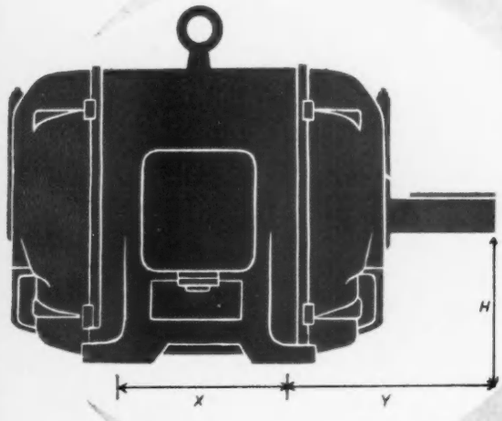
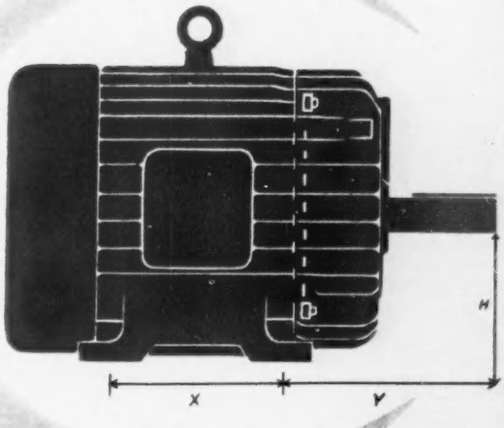
THE ENGINEER

MARCH 18, 1960 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

Dimensional Twins...



DRIP-PROOF type KN-C



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In stock—all standard ratings up to 40 h.p.

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Motor & Control Gear Division
RUGBY, BIRMINGHAM & MANCHESTER, ENGLAND

INCORPORATING THE MOTOR & CONTROL GEAR INTERESTS OF BTH & MV

What makes *this* diesel crane better than others...

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Takes less time. Hoists 5-ton load *on single line* at high speed.

ABSOLUTE PRECISION LOAD-LOWERING
New power-lowering feature provides creeping speeds for accurate placing of loads.

NONE TO COMPARE FOR GRABBING DUTIES
Sound construction and equipment, including Smith's automatic double-barrel (operated by single control), gives incomparable grab service.

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Many of the larger firms in iron and steel use this machine.

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Supplied to suit standard British gauge or as required.

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Gardner 6LW, or other leading makes of equivalent horsepower, can be fitted if required.

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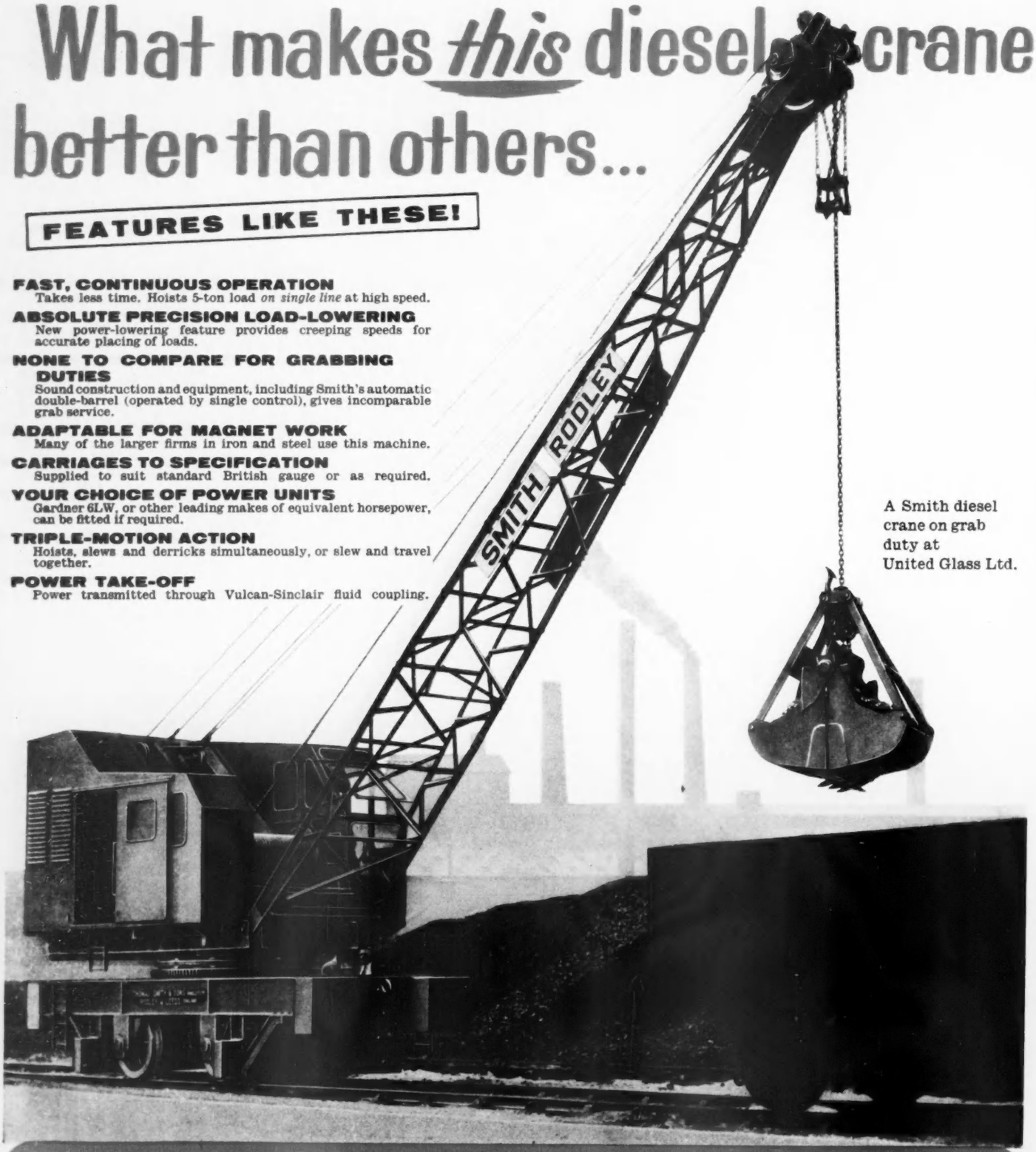
Hoists, slews and derricks simultaneously, or slew and travel together.

POWER TAKE-OFF
Power transmitted through Vulcan-Sinclair fluid coupling.



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THE ENGINEER

Established 1856

No. 5434 MARCH 18, 1960 VOL. 209

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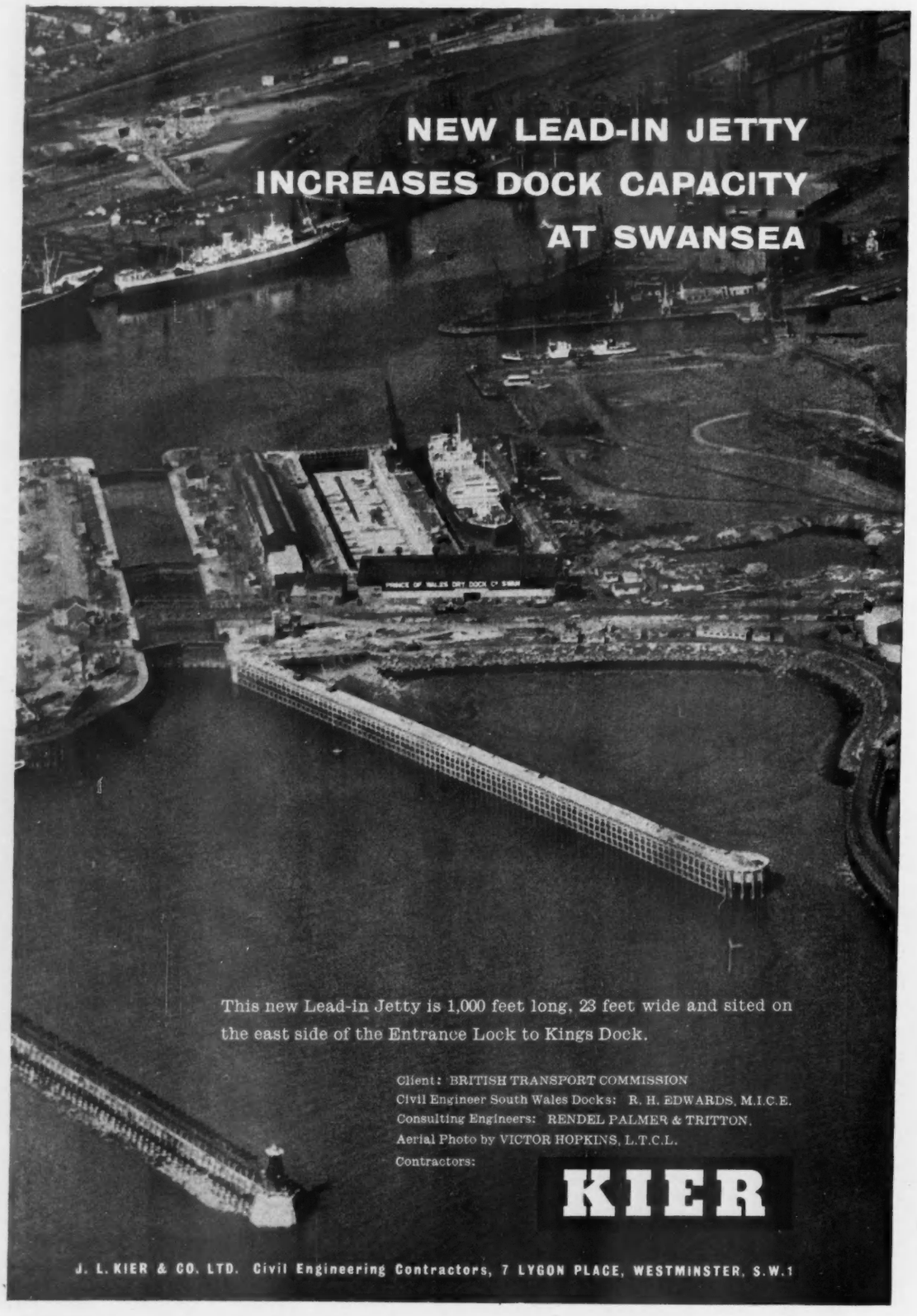
NEW LEAD-IN JETTY
INCREASES DOCK CAPACITY
AT SWANSEA
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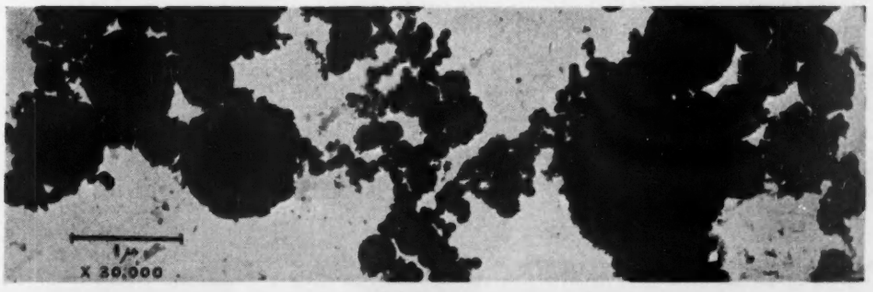
Micro photograph of dust particles collected by the 'Visco-Beth' Patent Automatic Dust Collectors installed at the works of Samuel Fox & Co. Ltd. The lower picture shows the arc furnace with fume and dust collecting ducting.



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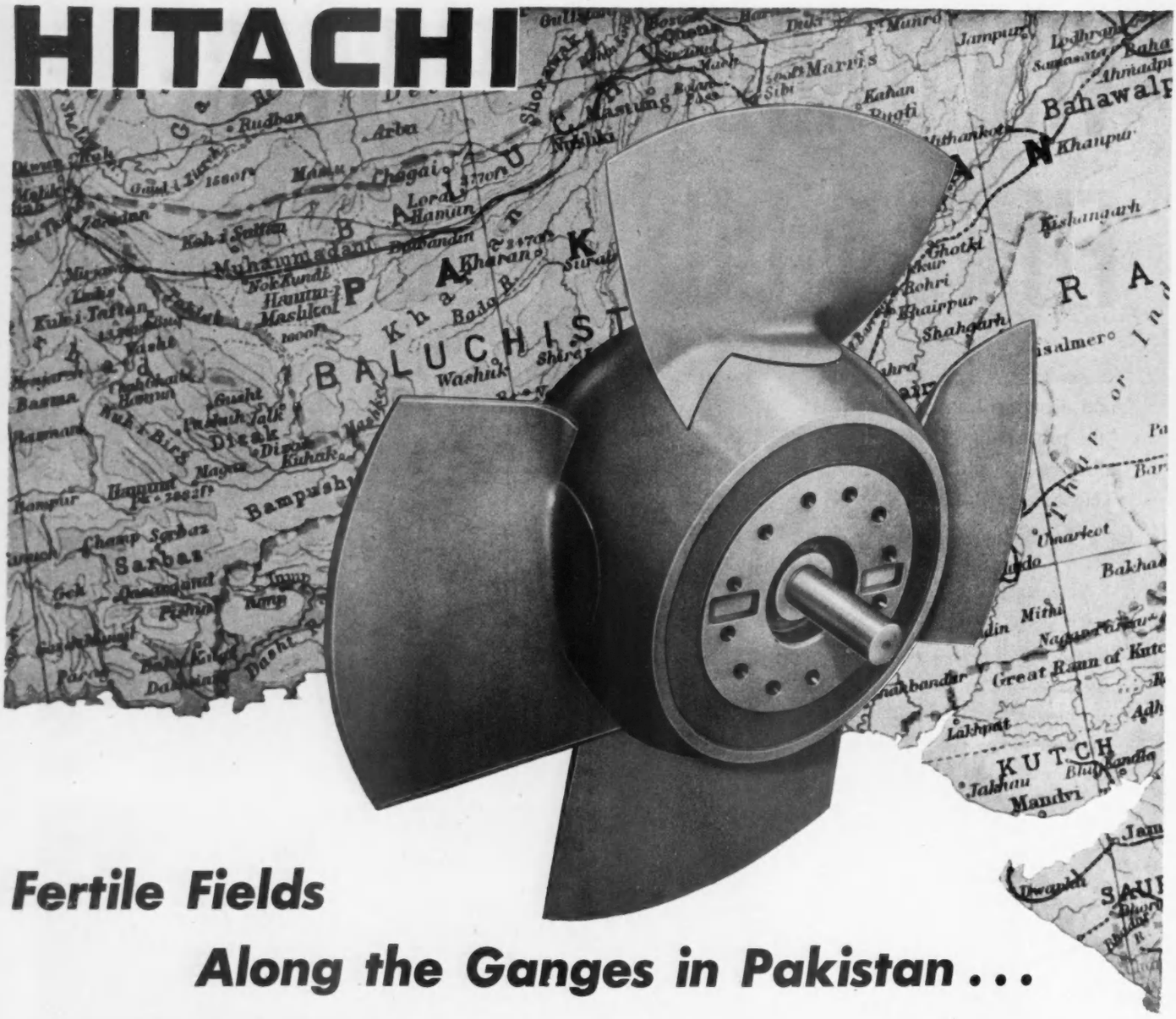
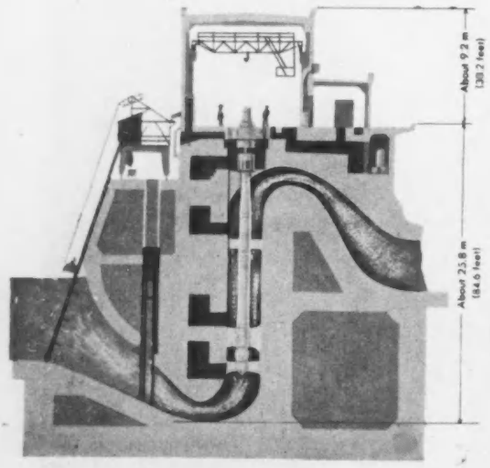


Fertile Fields

Along the Ganges in Pakistan . . .



Outline of this Pumping Plant

Type-Porm	Vertical Shaft Direct Motor Driven Adjustable Blade Axial Flow Pump
No. of main Pumps	3
Unit Capacity	1,700 m³/min (60,040 ft.³/min)
Total Head	8.25 m (27')
Impeller Diameter	2,700 mm (8.86')
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. . . will be made possible through the three (3) huge Vertical Type Adjustable Blade Axial Flow Pumps built by Hitachi for East Pakistan. Each pump has a motor output of 2,800 kW and a 2,700 mm impeller diameter. To be installed in East Pakistan for pumping water from the Ganges River during the dry season for irrigation purposes, the pump is only part of the equipment for the huge Pump Station being supplied by Hitachi, including the screen and gate on the suction side, a trash rack crane and an electric overhead crane.

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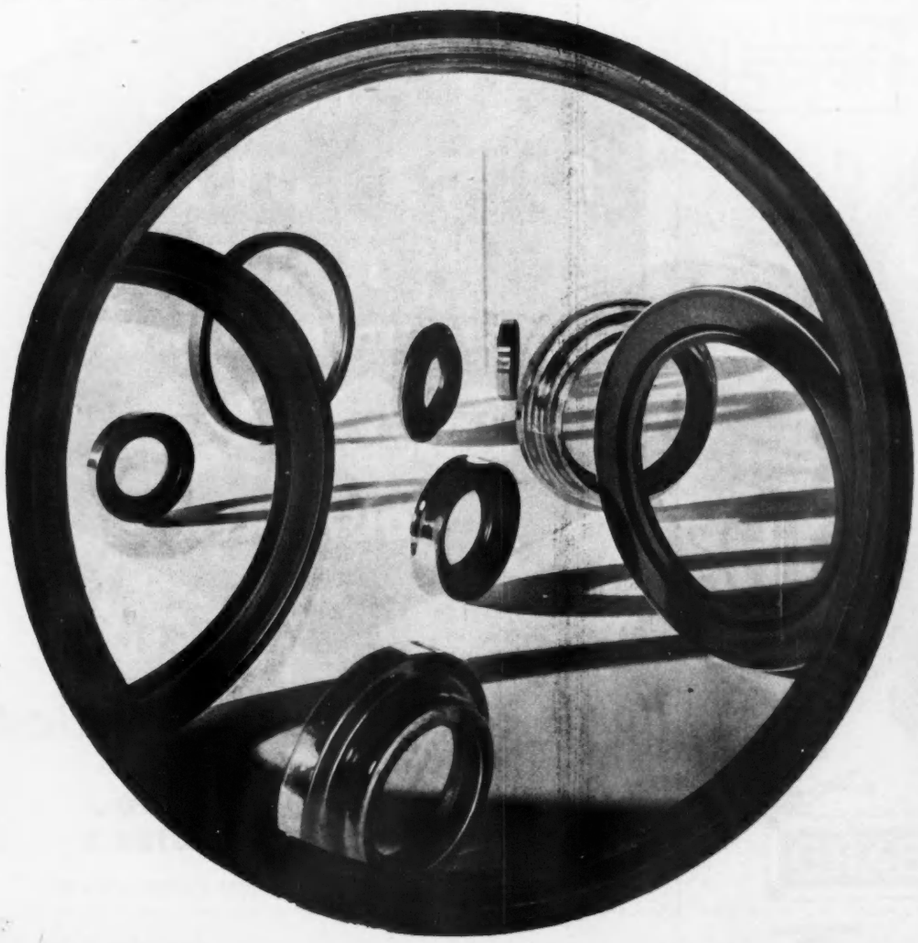

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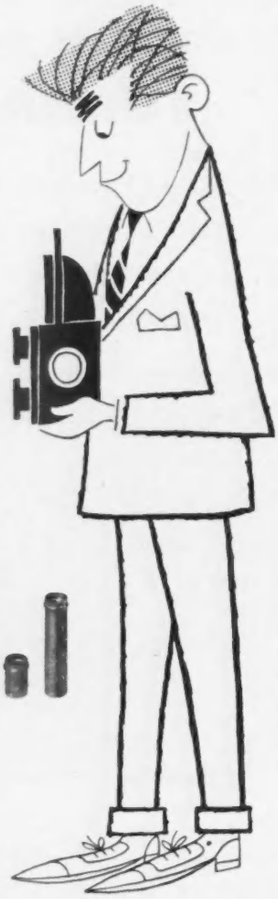

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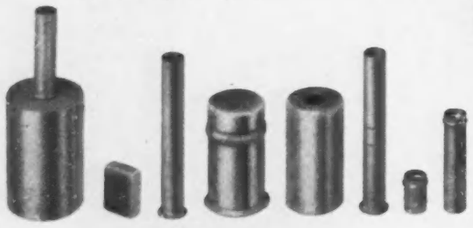

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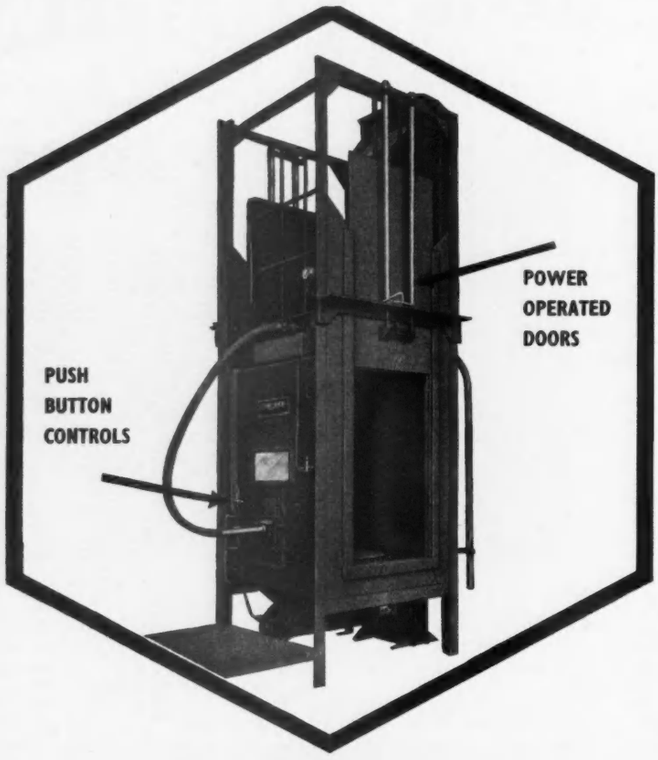

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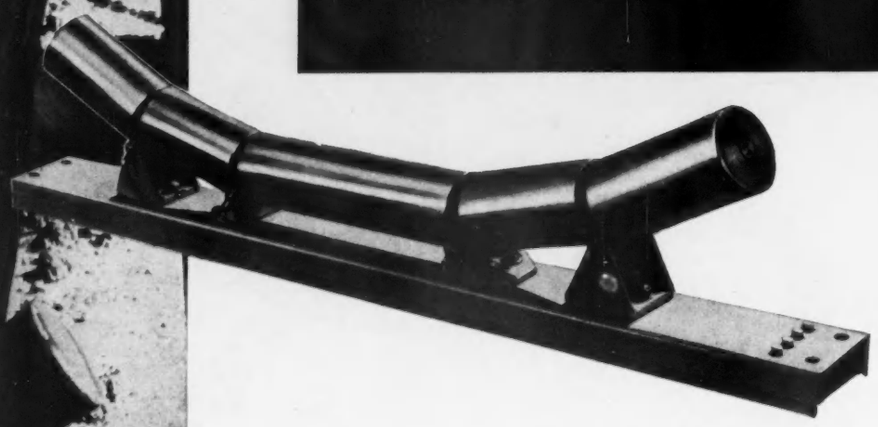

An idler for a 48-in. belt, with nipples for recharging the seals from one side.

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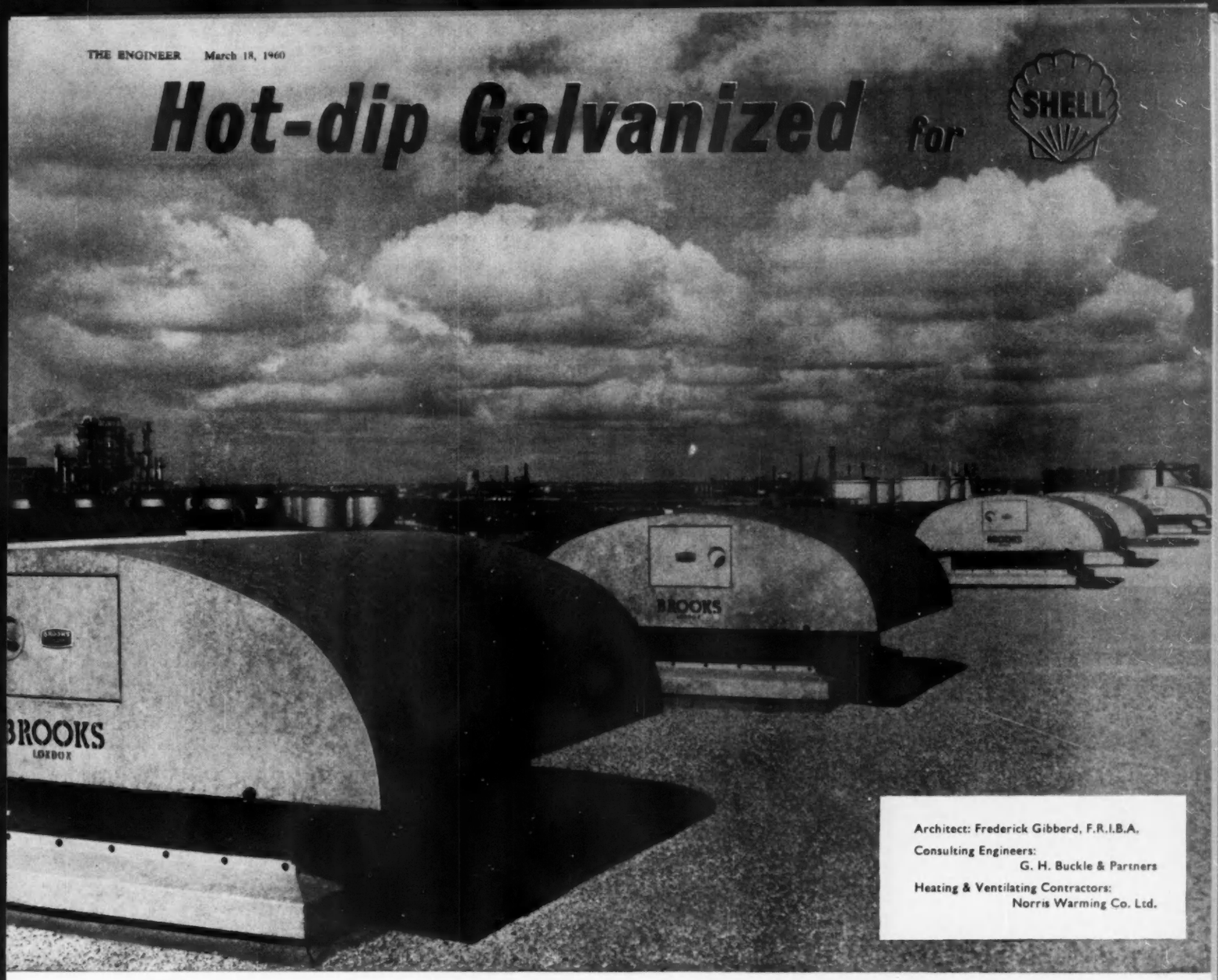

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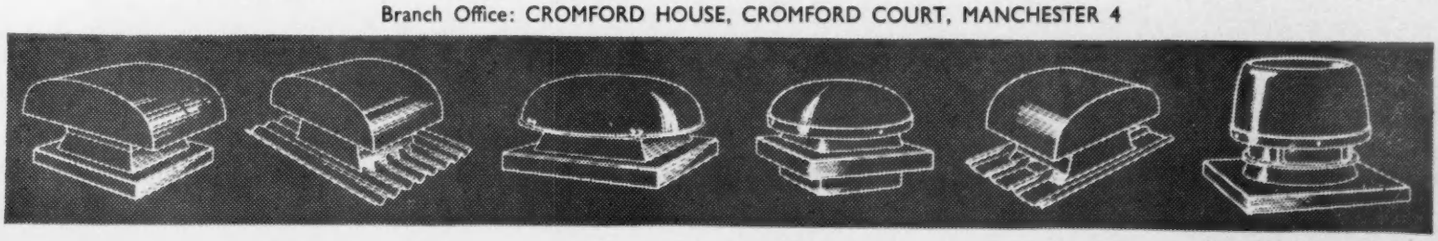

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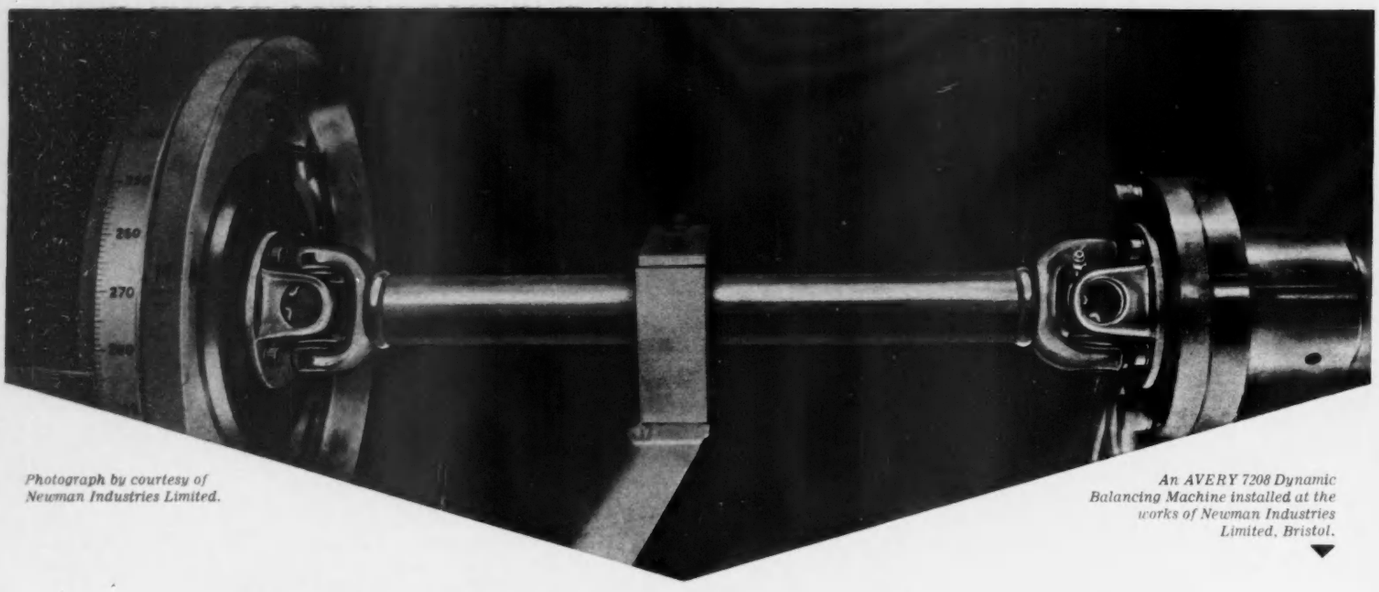

Photograph by courtesy of Newman Industries Limited.

An AVERY 7208 Dynamic Balancing Machine installed at the works of Newman Industries Limited, Bristol.

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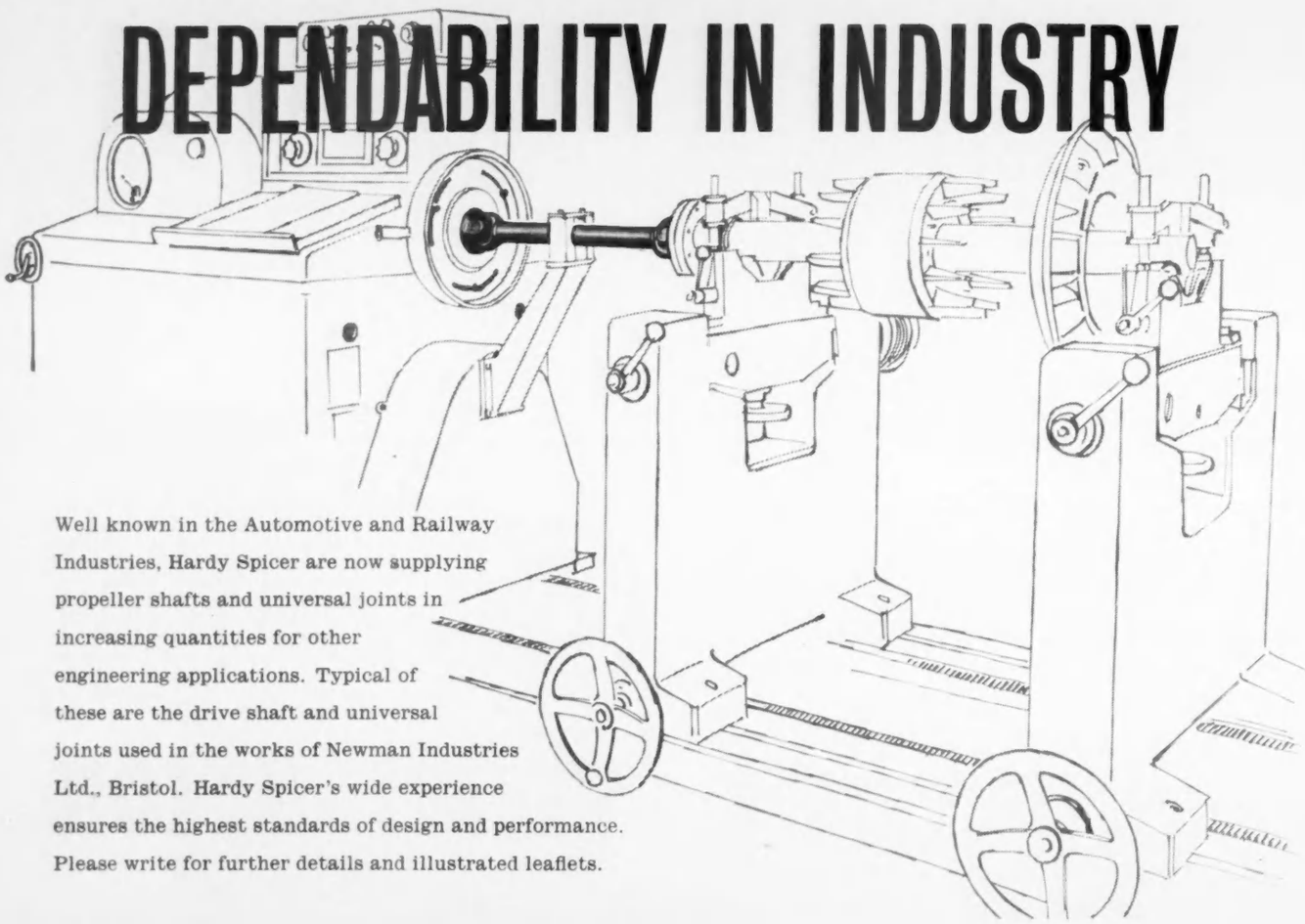

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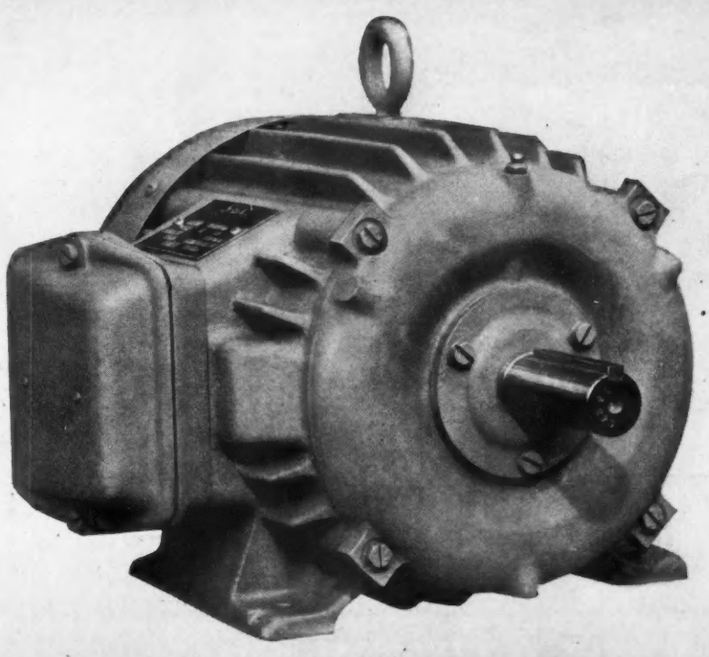
(with class 'E' insulation)



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(with class 'E' insulation)

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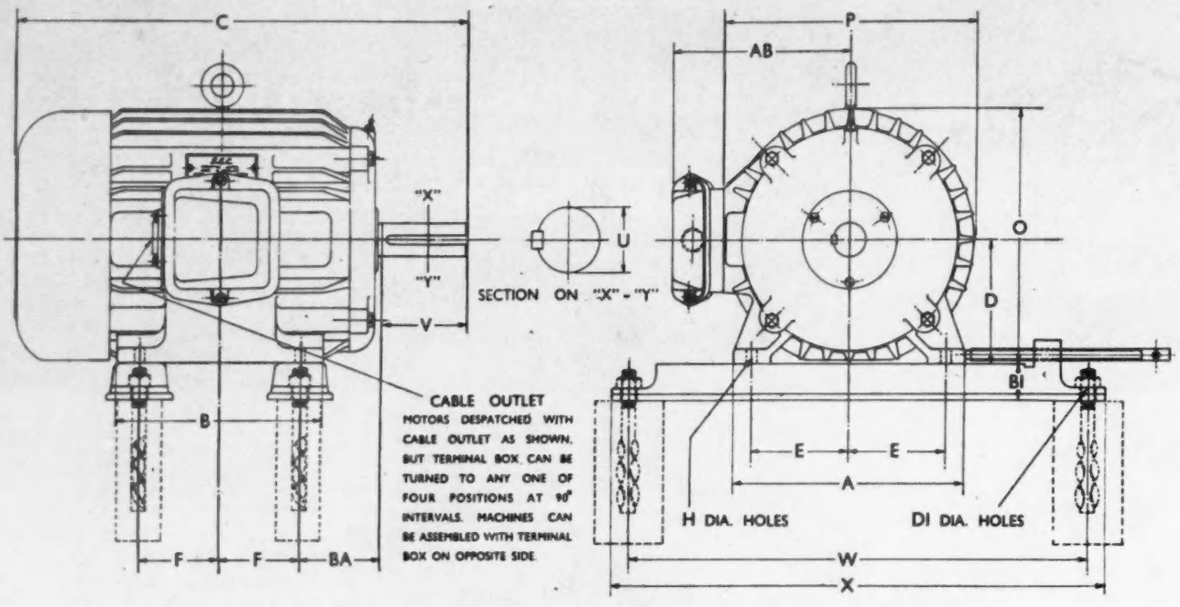

H.P.		Frame Size	Frame											Shaft Extension		Slide Rails			
1,500 r.p.m.	1,000 r.p.m.		A	AB	B	BA	C	D	E	F	H	O	P	U	V	W	X	BI	DI
1	½	D162	8	6½	5¼	2¾	13 5/16	4	3⅜	2	⅜	8 1/16	8⅛	·7500	2¼	20 3/32	21 21/32	1 9/16	¾
1½	¾	D164	8	6½	6¼	2¾	14¼	4	3⅜	2½	⅜	8 1/16	8⅛	·7500	2¼	20 3/32	21 21/32	1 9/16	¾
2	1	D182	9	7 1/16	6	2¾	14¾	4½	3¾	2¼	7/16	9 1/16	9⅛	1·1250	3	20 3/32	21 21/32	1 9/16	¾
3	2	D184	9	7 1/16	7	2¾	15¾	4½	3¾	2¾	7/16	9 1/16	9⅛	1·1250	3	20 3/32	21 21/32	1 9/16	¾
5	3	D213	10⅛	7⅜	7½	3½	18 3/32	5¼	4¼	2¾	7/16	10¾	11 1/32	1·3750	3¾	20 3/32	21 21/32	1 9/16	¾
7½	5	D215	10⅛	7⅜	9	3½	19¾	5¼	4¼	3½	7/16	10¾	11 1/32	1·3750	3¾	20 3/32	21 21/32	1 9/16	¾

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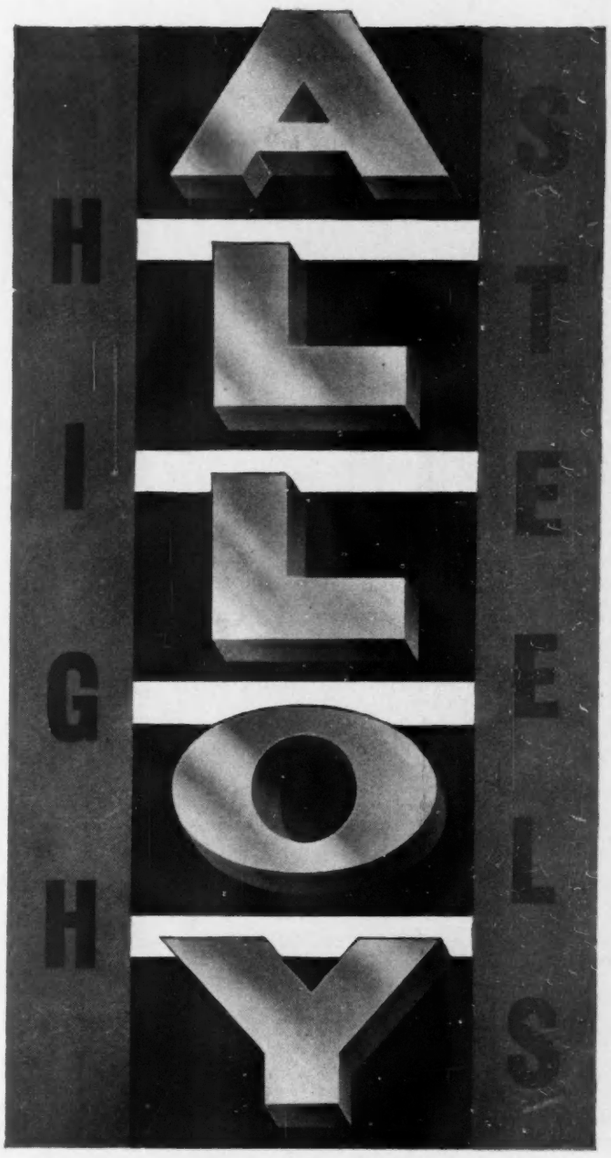

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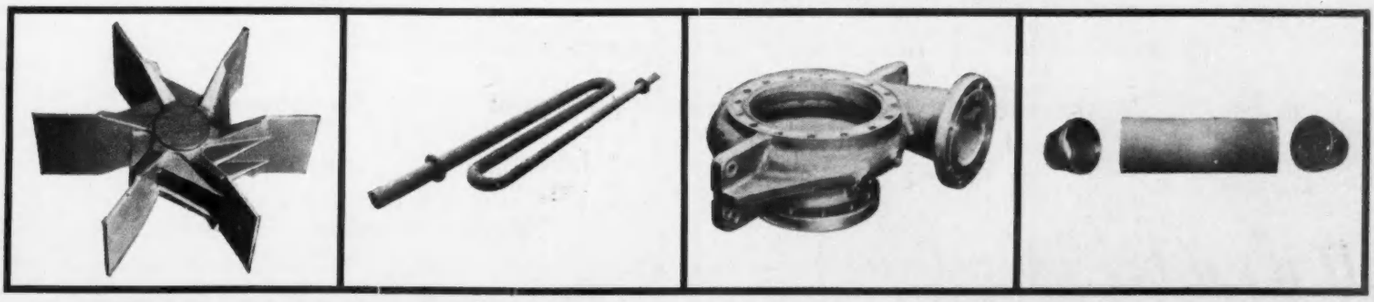

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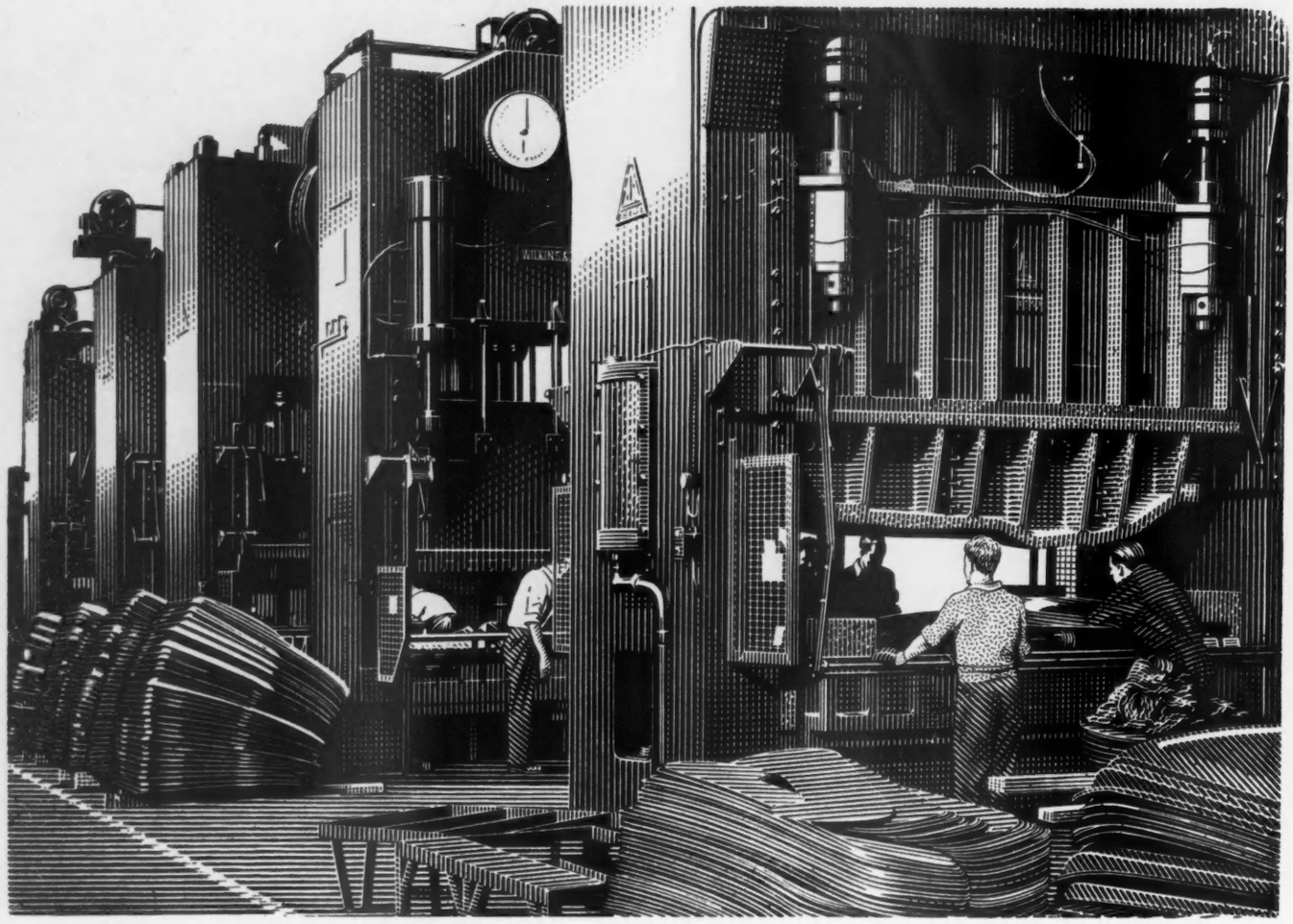

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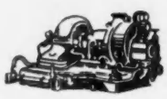

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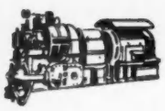

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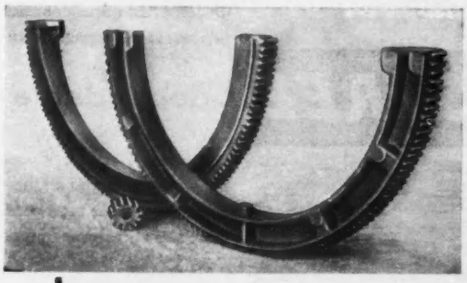

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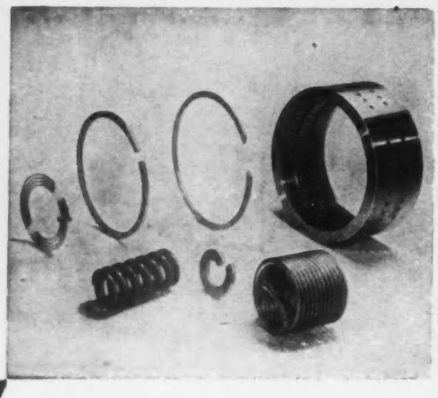

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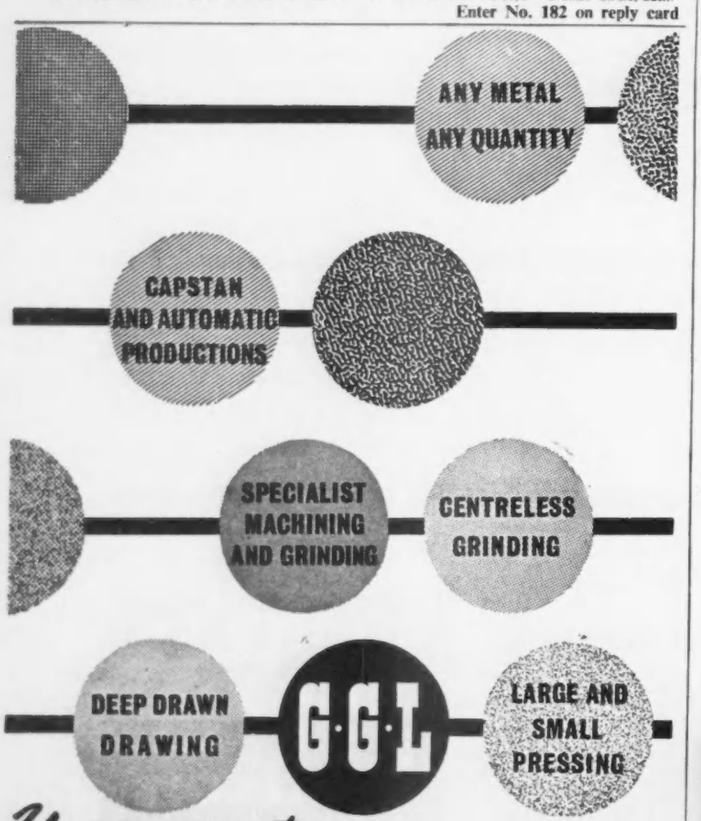

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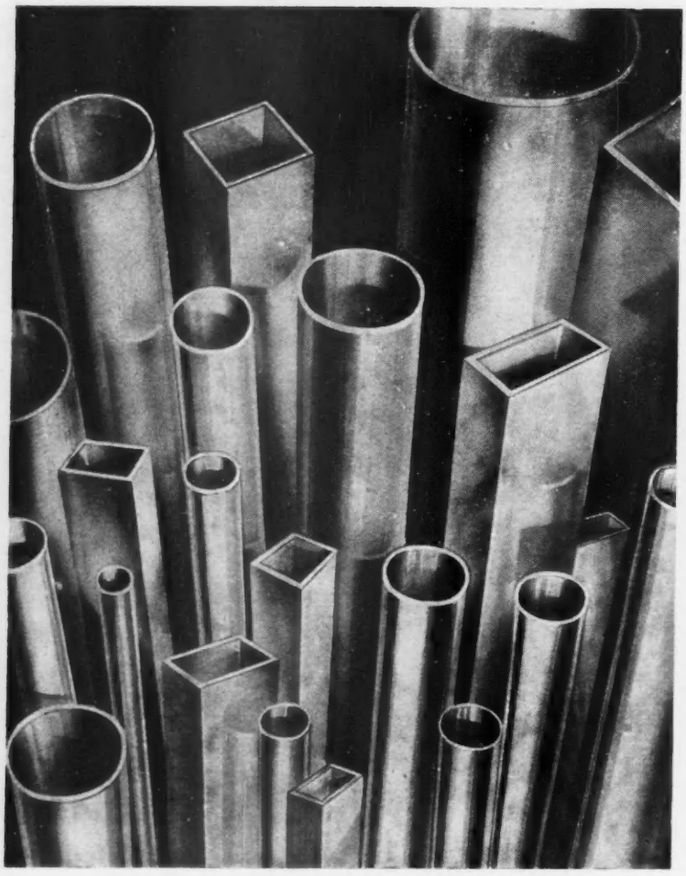

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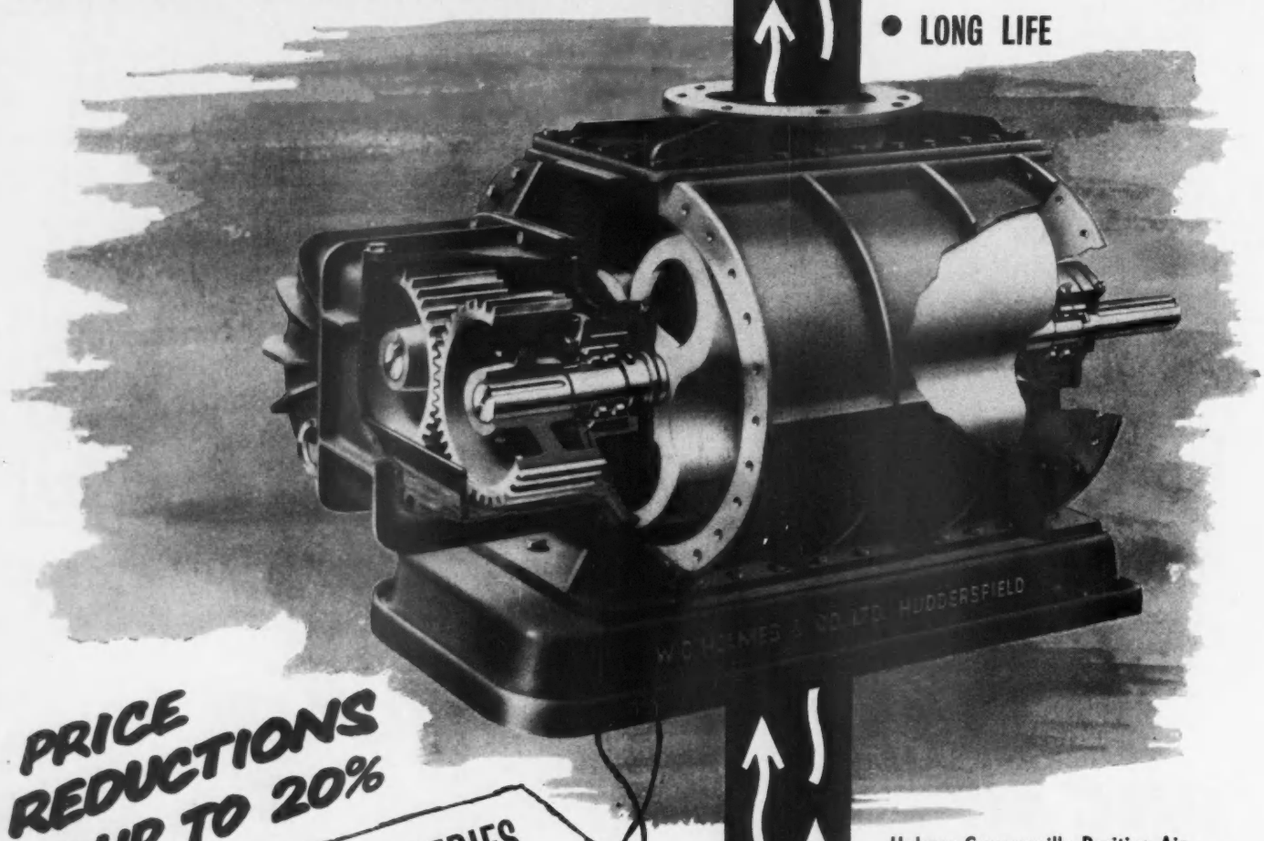

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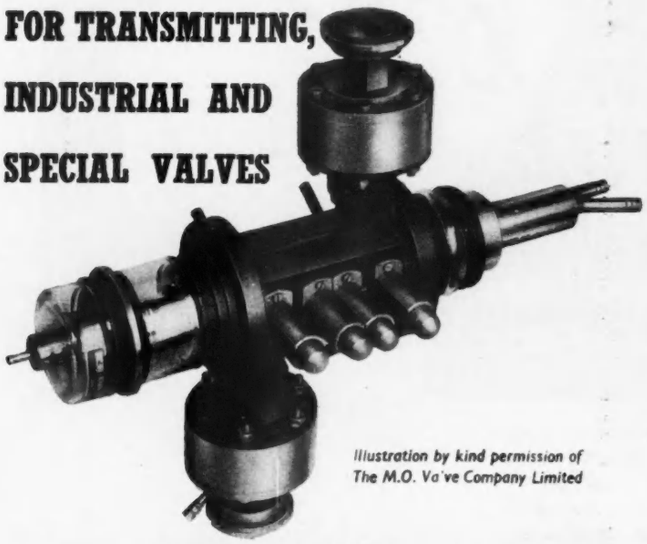

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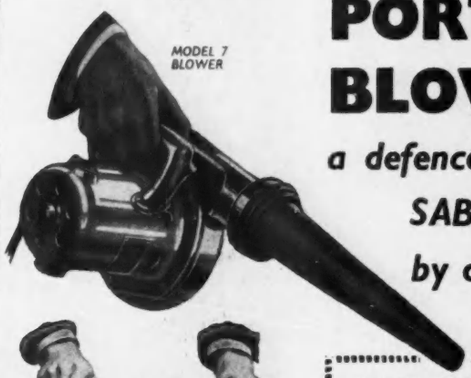

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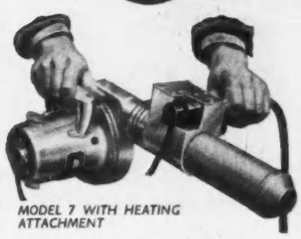

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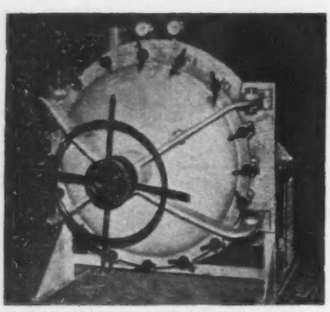

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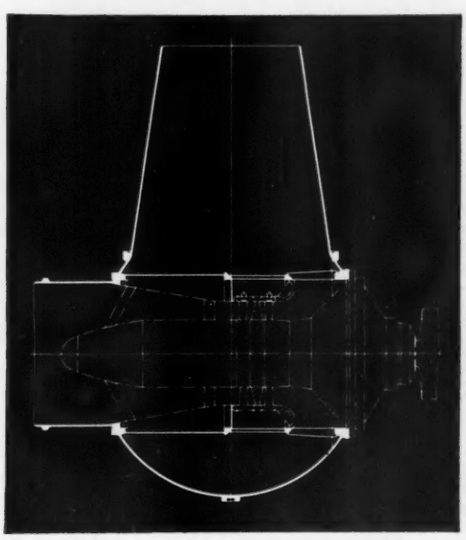

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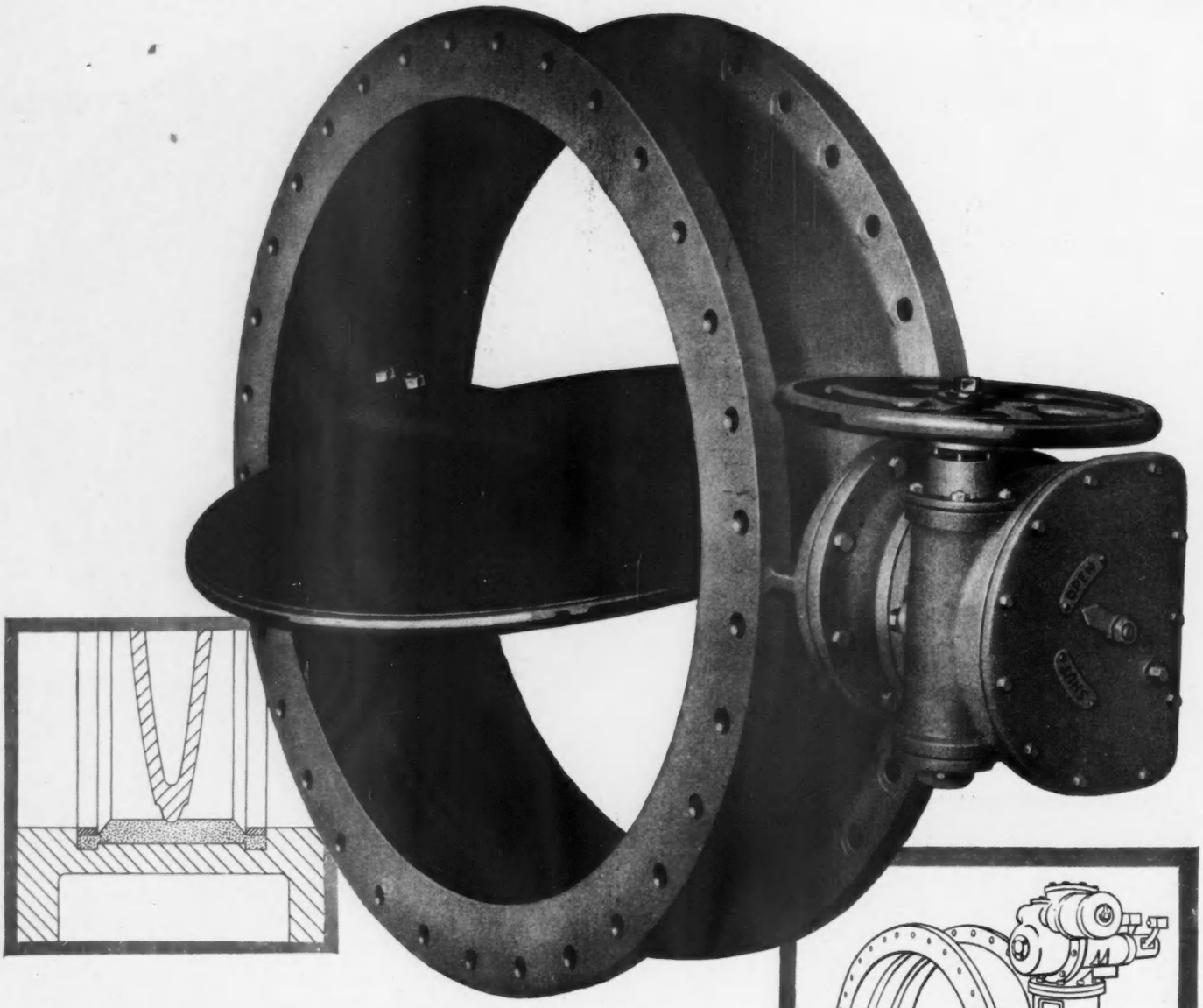

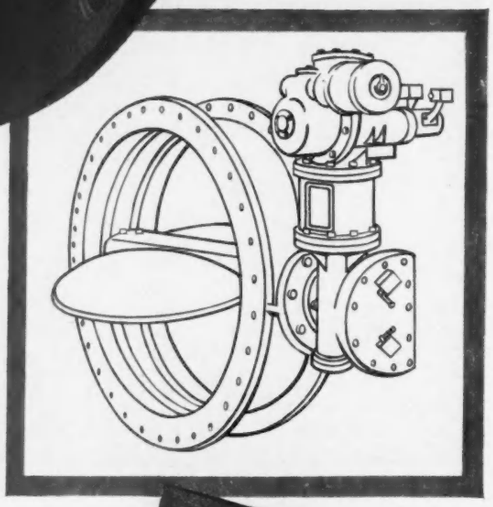

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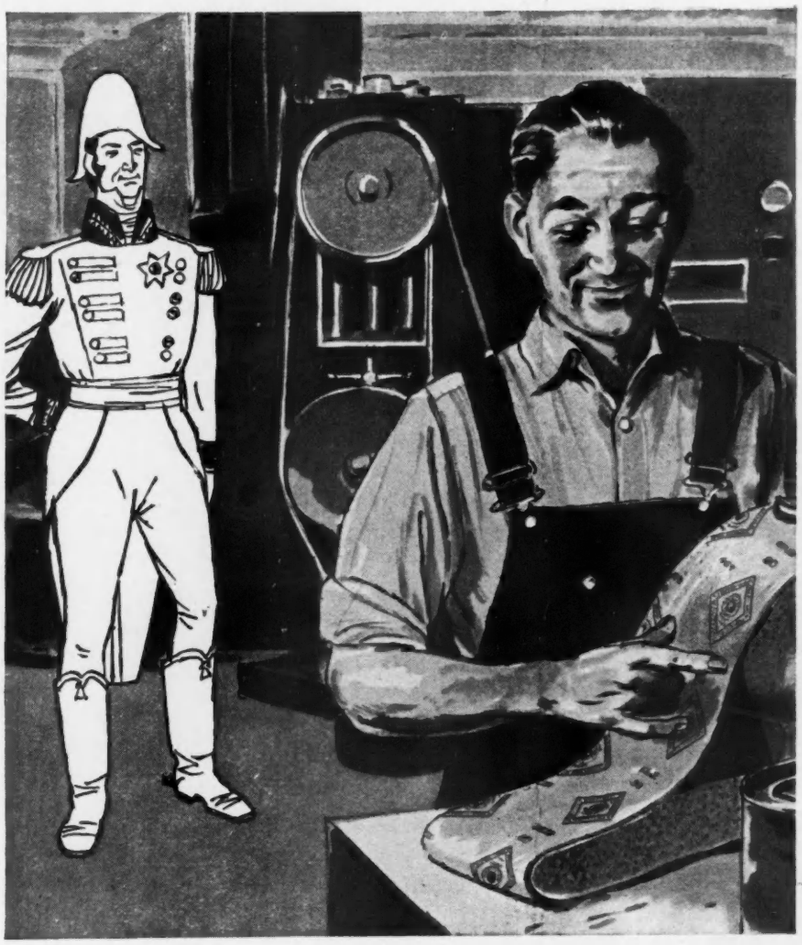

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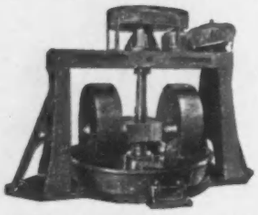

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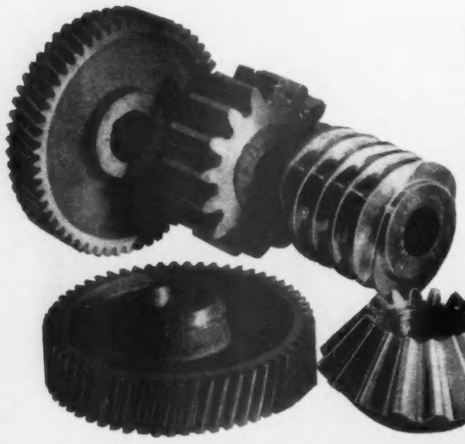

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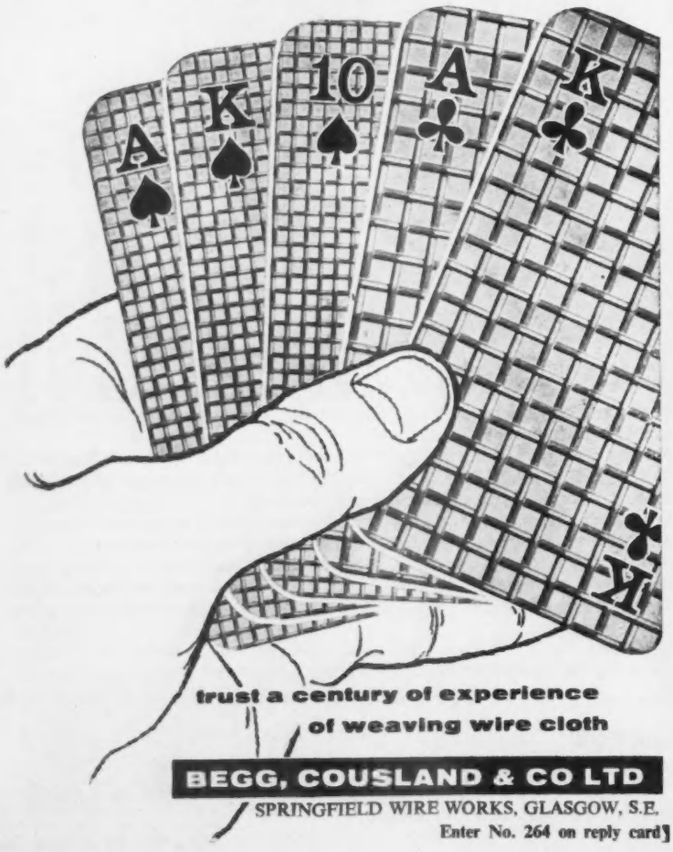

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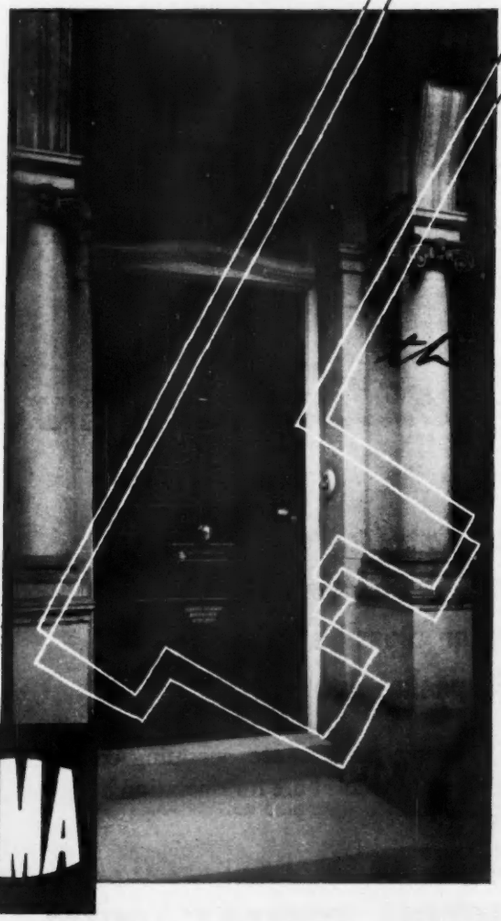

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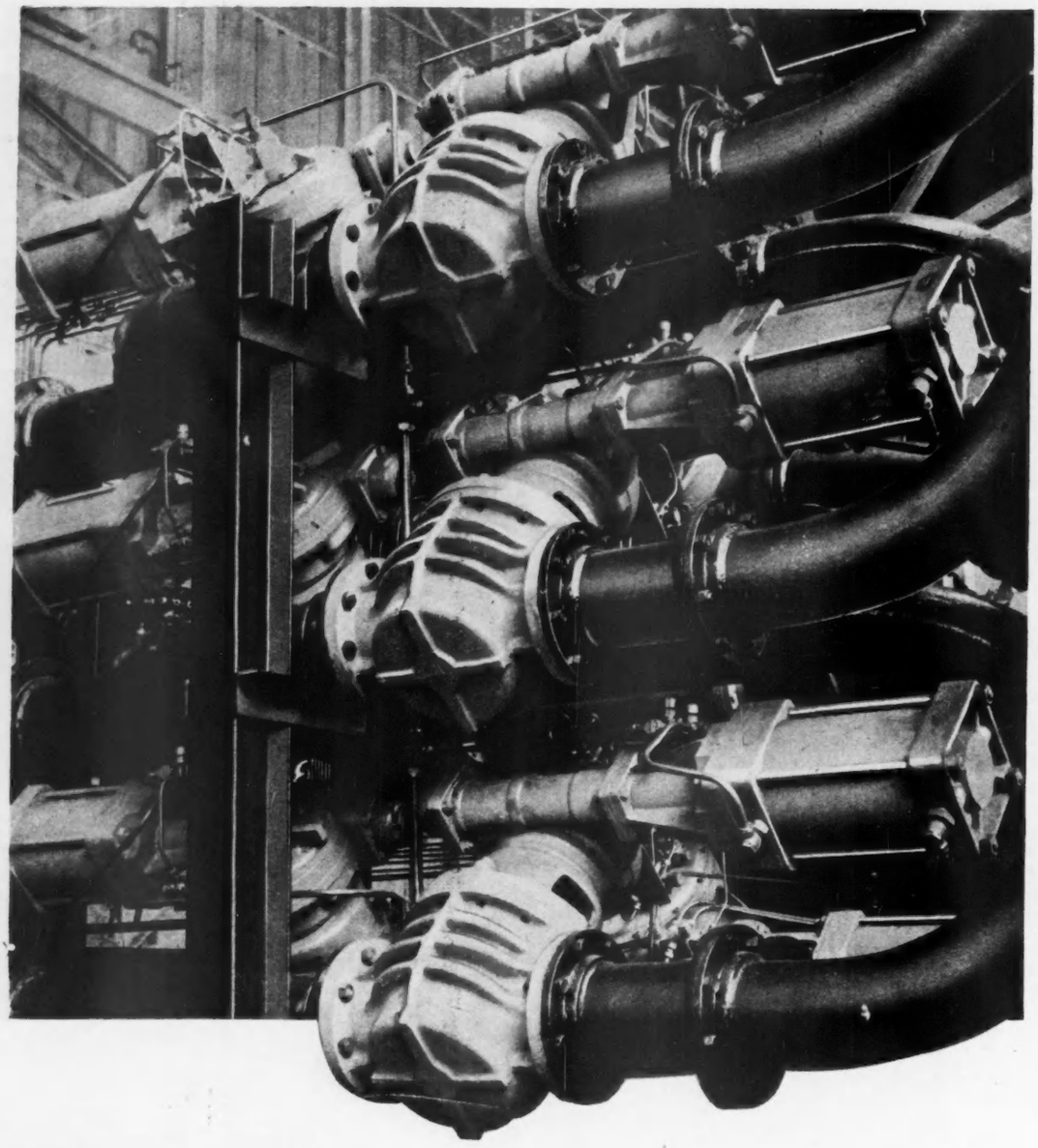
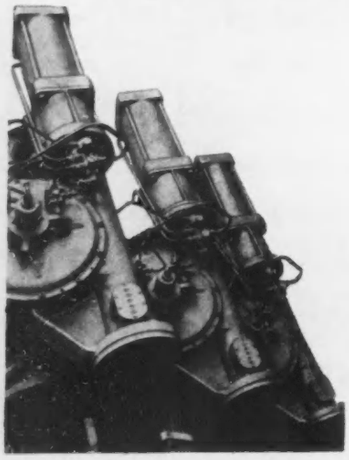


Audco Power Operated Valves installed on a prototype Lock Hopper for hydraulic transportation of coal. Designed and developed by the Central Engineering Establishment, N.C.B., Stanhope, Brethy, for installation in Wood End Colliery.

AUDCO *Power Operated* valves



- **can be remote controlled**
- **can be operated in regularly timed cycles**
- **can be opened or closed automatically**
- **permit faster opening and closing**

—they increase plant efficiency and reduce operating costs, and are available in a range of sizes up to 24″ bore for operation by pneumatic, hydraulic or electric power.
Further details supplied on request.

AUDLEY ENGINEERING COMPANY LIMITED

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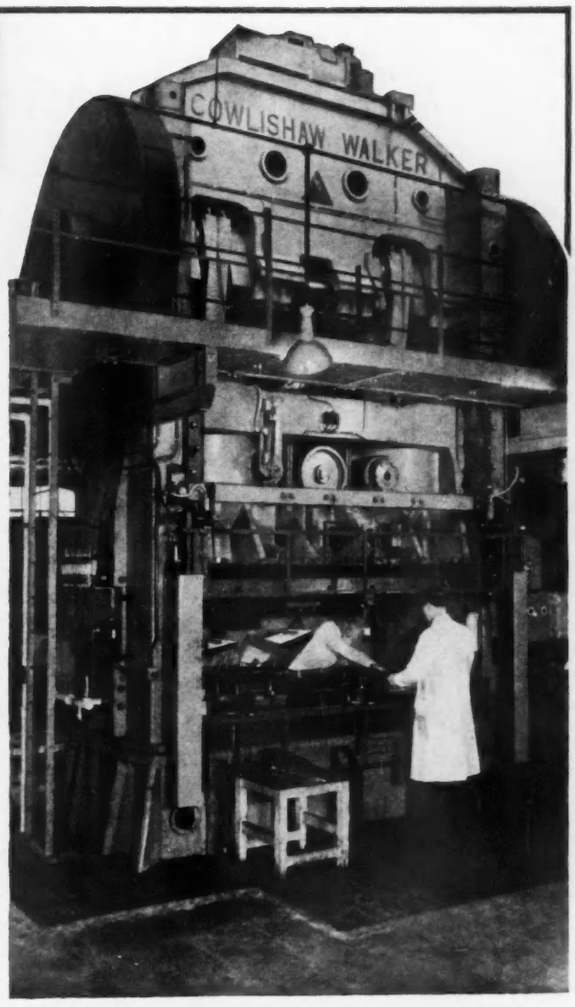

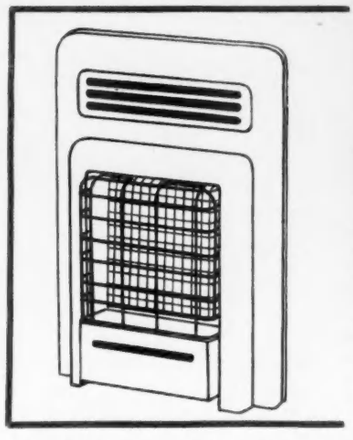

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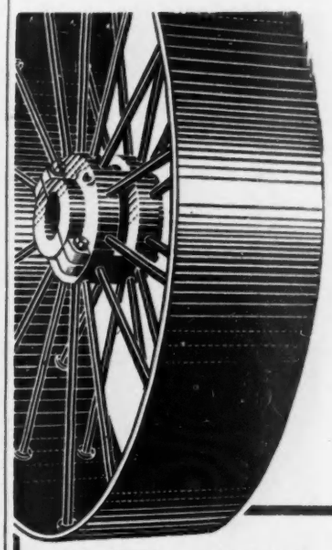

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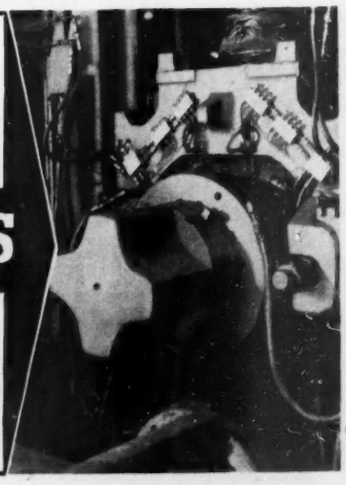

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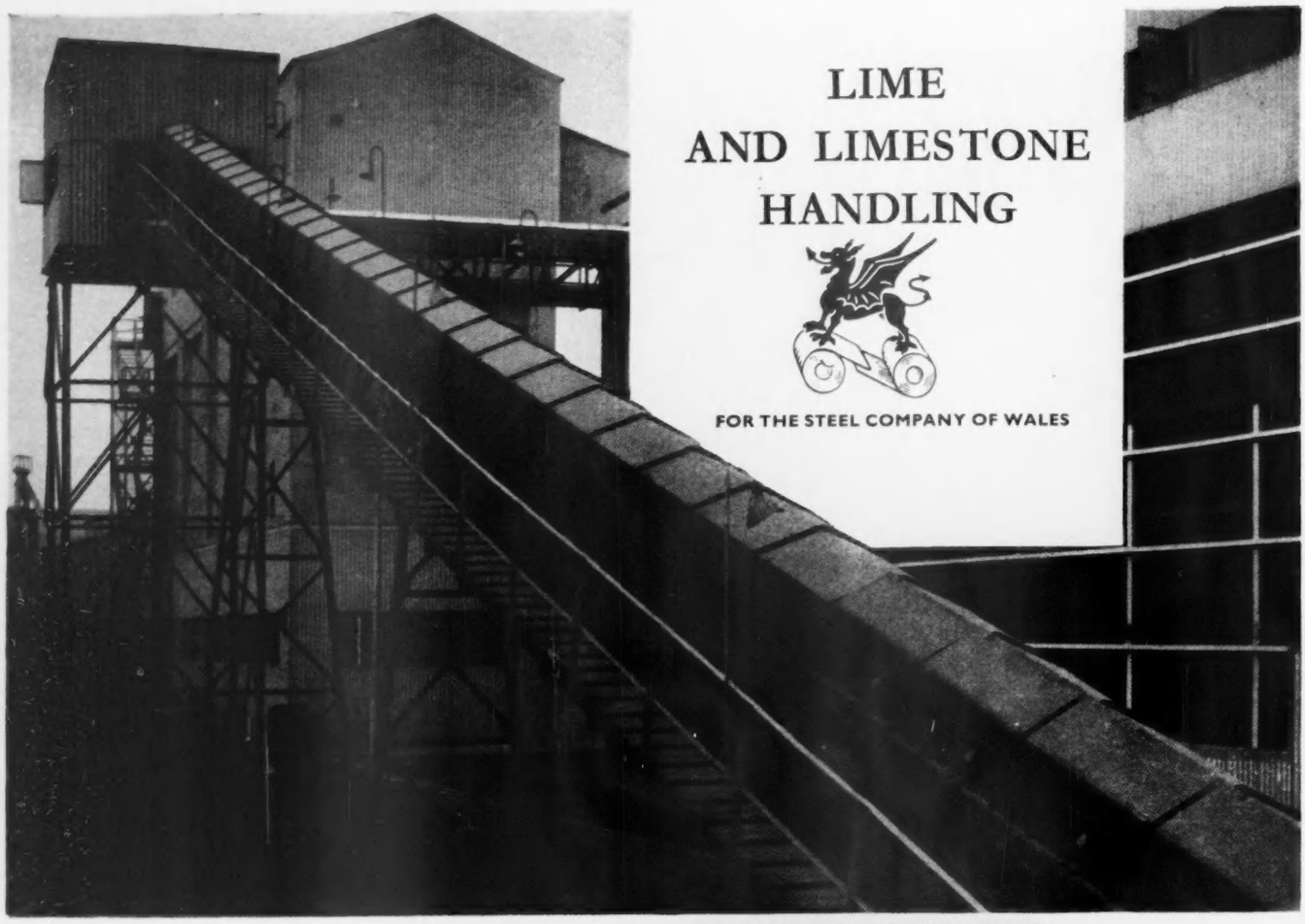

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FOR THE STEEL COMPANY OF WALES

Another important contribution by

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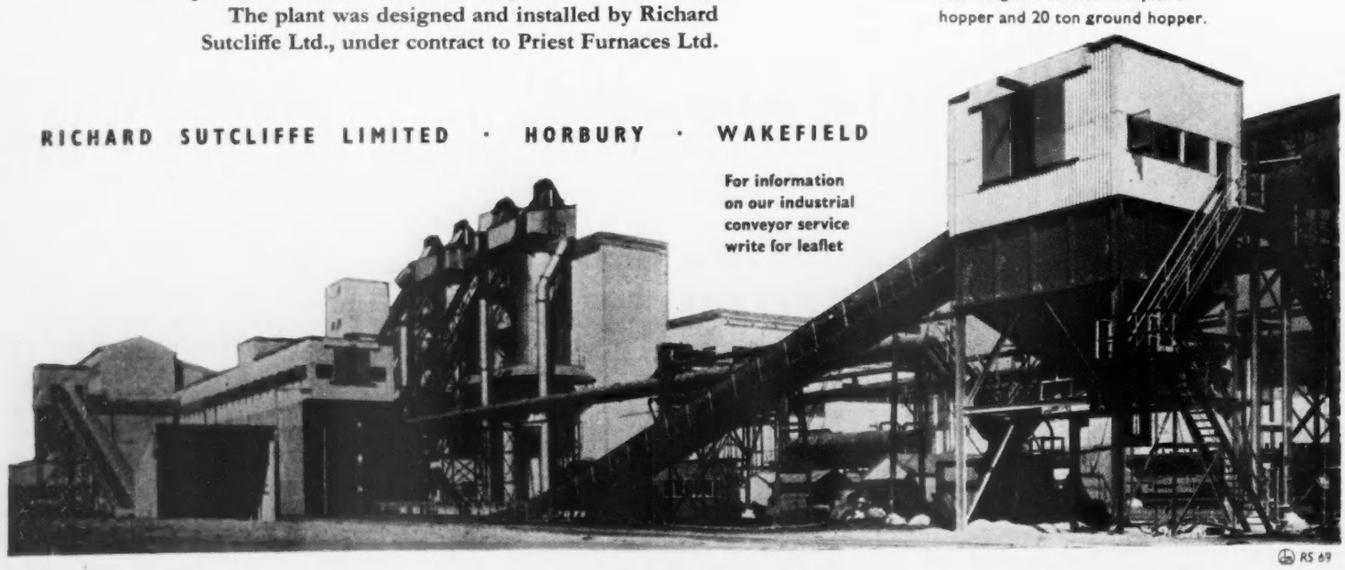
Above: Main conveyor to the limestone holding bunkers.

Below: Photograph showing the complete layout of the Plant including the limestone rejection hopper and 20 ton ground hopper.



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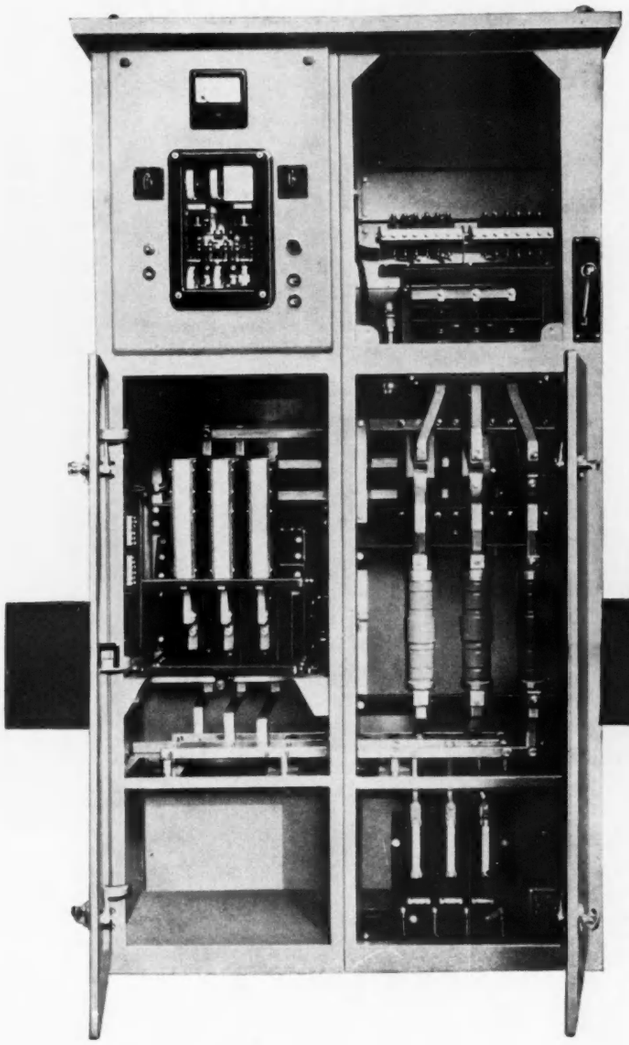
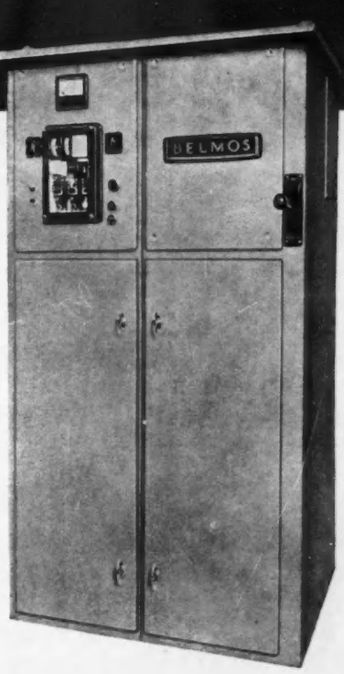
THE BELMOS 3·3kV AIR-BREAK CONTACTOR STARTER



Rigorously tested in the Company's own research laboratory, the type K contactor starter is the latest product of the Belmos development team and continues the well-established Belmos tradition of good design and reliability. Suitable for the direct-on-line starting of 3·3kV motors up to 600 h.p., it can be housed in a free-standing pillar or grouped with similar units to form a switchboard.

- ★ Air-break contactor rated at 150 amperes. Breaking capacity of 1,300 amperes at 3·3 kV, 0·25 power factor.
- ★ D.C. operating magnet supplied from 3,300/110 volt transformer within the pillar.
- ★ Reversing or Earthing isolator, mechanically and electrically interlocked, with 12 auxiliary switches, a.c. or d.c.
- ★ Busbars designed to withstand 150 MVA for 3 seconds.
- ★ Optional earth leakage protection.
- ★ Comprehensive control arrangements, local and remote, with sequence interlocking and automatic sequence starting.
- ★ Provision for auxiliary services, such as brake protection, local lighting, etc.



the type K starter is fully described and illustrated in leaflet J 240 which is available on request.

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FT 239/2

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CLYDE-BOOTH

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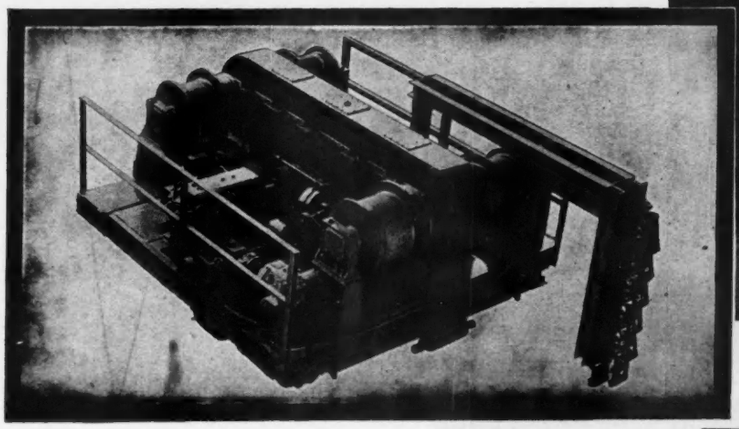
(ABOVE) Clyde-Booth four point suspension electric overhead travelling magnet crane at Messrs. Colvilles Ltd., Ravenscraig Works.
(RIGHT) The hook with slip-ring gear for the magnet, showing attachment of the four ropes.
(BELOW) The special four barrel crab.



With the introduction of higher rates of acceleraton and braking on traversing and long travel motions, in order to get the maximum output from overhead travelling cranes, magnet cranes with multiple splayed ropes are finding favour.

This type of suspension effectively damps out swinging of the load due to acceleration and braking forces.

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D

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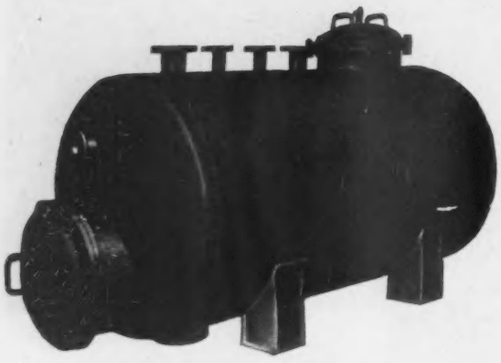

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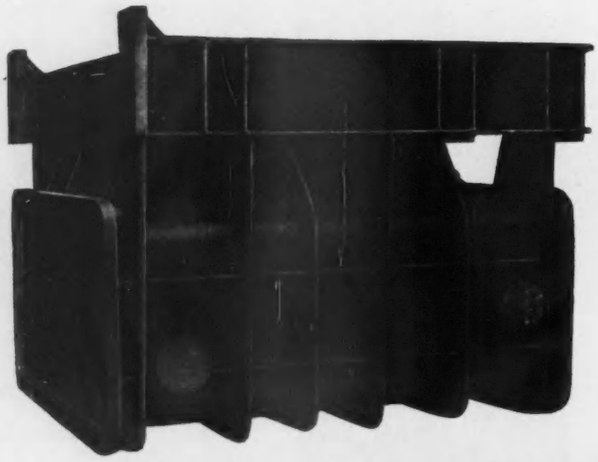

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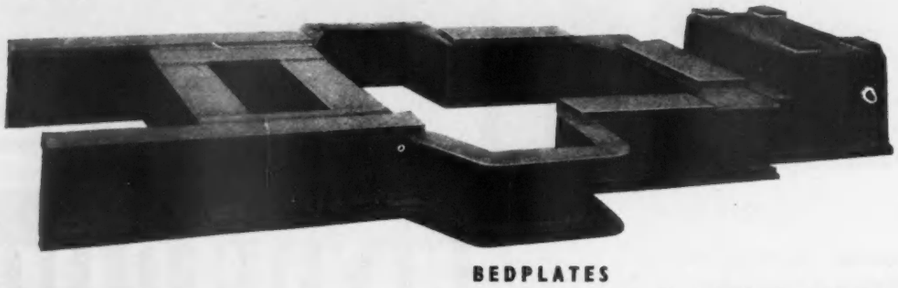

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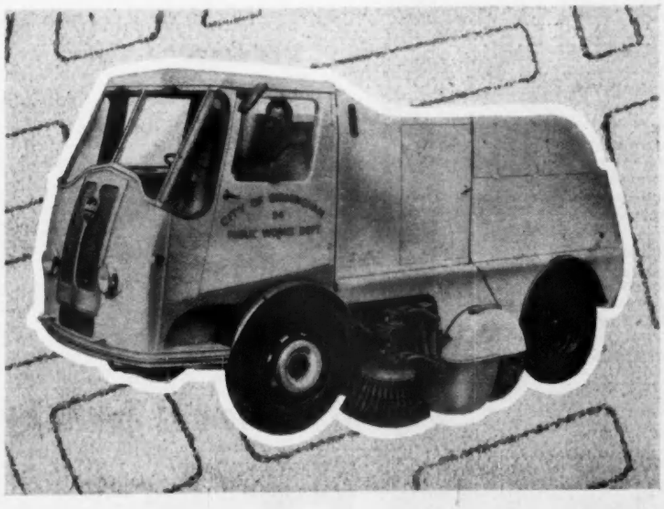

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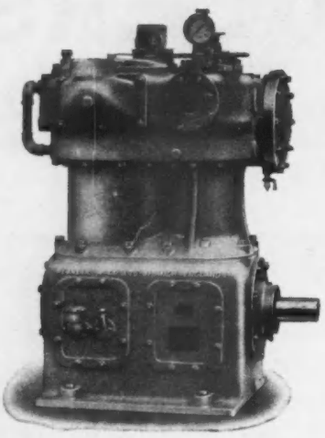

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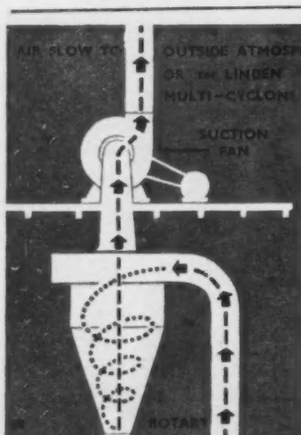

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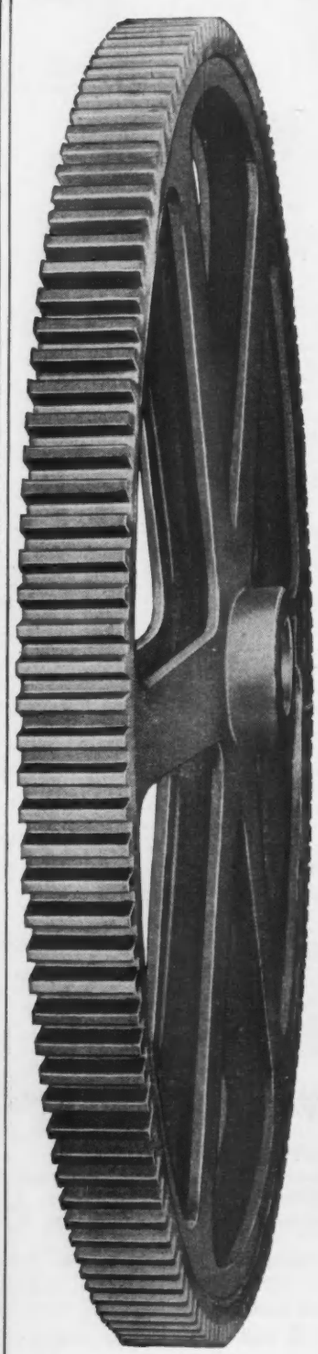

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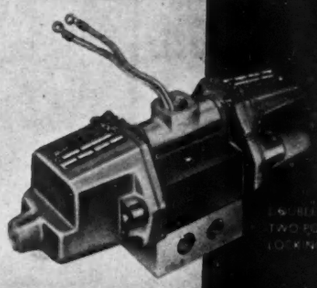

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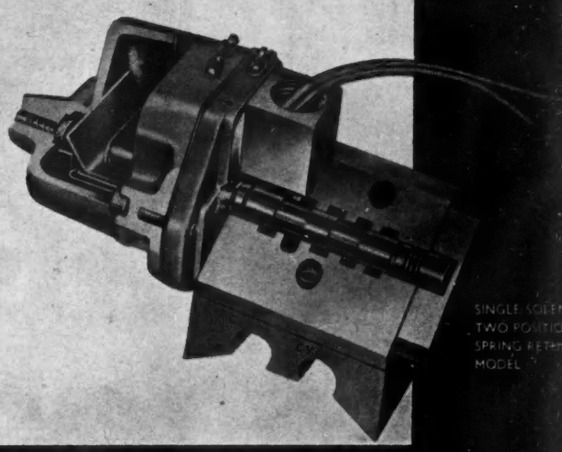

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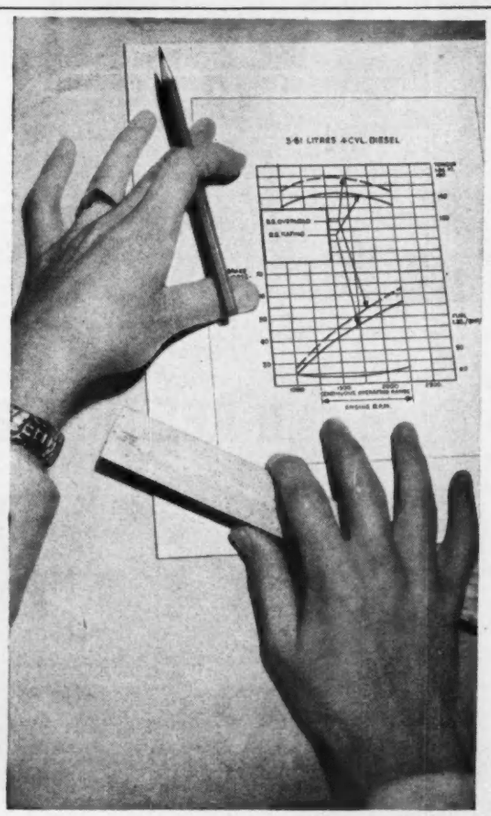

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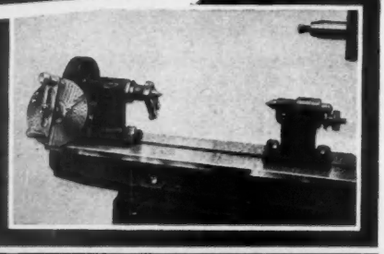

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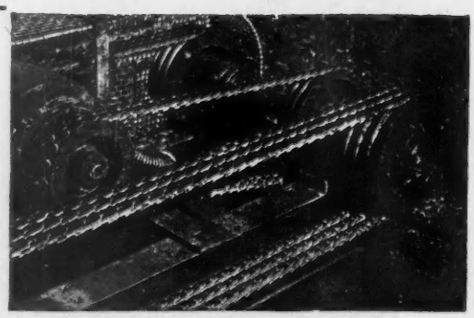

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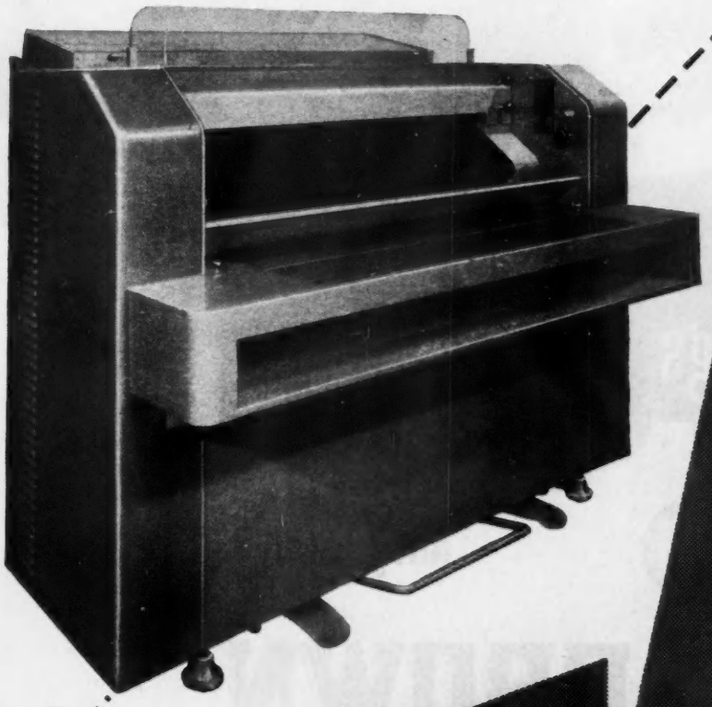
The Ilford AZOFLEX Model 246 Combine printing and developing machine (formerly known as Model 46/35) is designed for use in the print room of the large drawing office. It does not produce unpleasant fumes and special ventilating systems are thus unnecessary, making it a simple matter to move the machine to a new position at any time.



- Exposure, development and print delivery synchronized for simplicity of operation.
- All controls conveniently located for rapid, effortless adjustment.
- Pneumatic-assisted handling of originals and sensitised material to obviate fatigue.
- Complete design co-ordinated for exceptionally high potential output.
- Excellent mechanical layout giving silent, vibrationless running.
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Capacity: rolls and cut sheets up to 42 in. wide.
Printing speed: from 2 ft. to 30 ft. per minute.
Lamp: H.P.M.V. quartz, 3,000 watt.
Dimensions: height, 58 in., width, 72 in., depth (tray extended) 80 in.
Weight: approximately 1,400 lb.

Subject to certain conditions, the majority of AZOFLEX photoprinting machines can be hired as an alternative to outright purchase.

ILFORD *Azoflex*

PHOTOPRINTING MACHINES & MATERIALS

Full details from
ILFORD LIMITED, INDUSTRIAL SALES DEPARTMENT AZ18H
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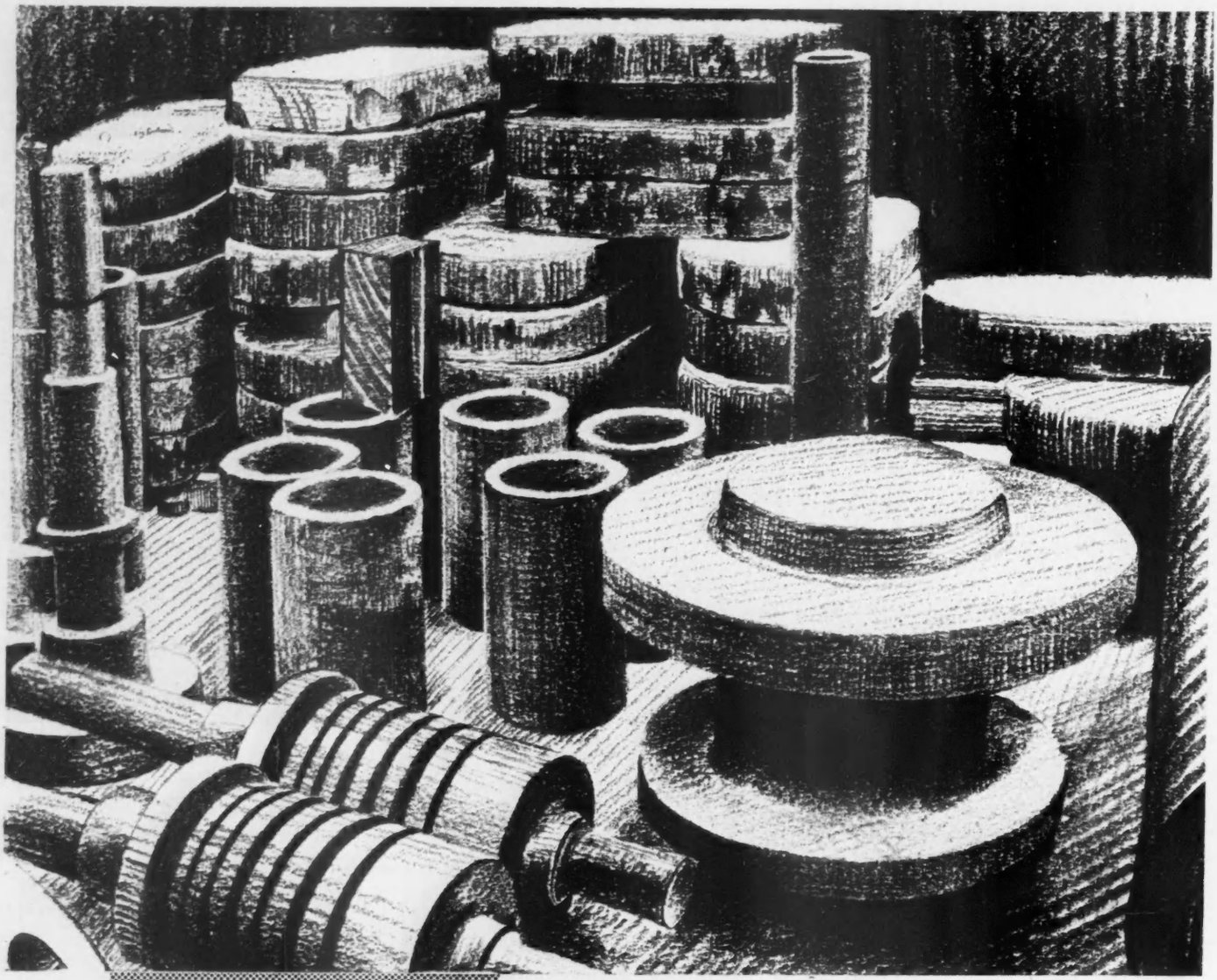

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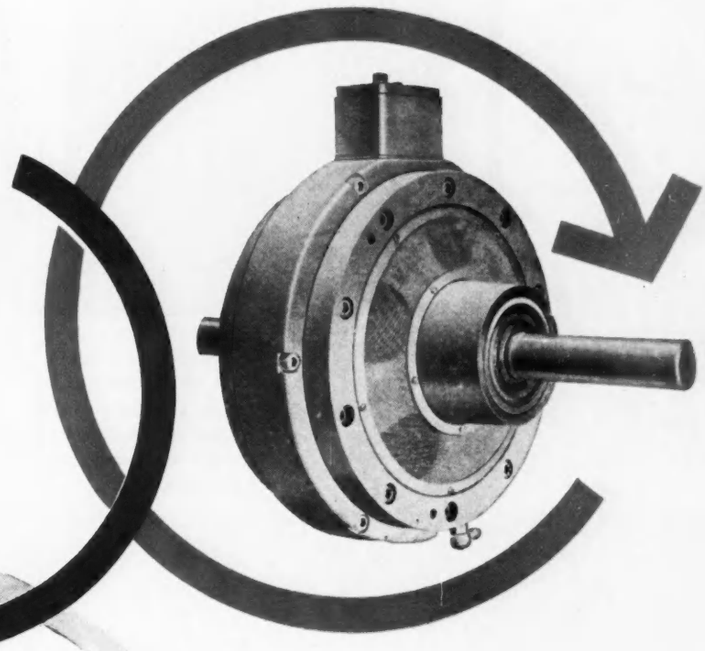

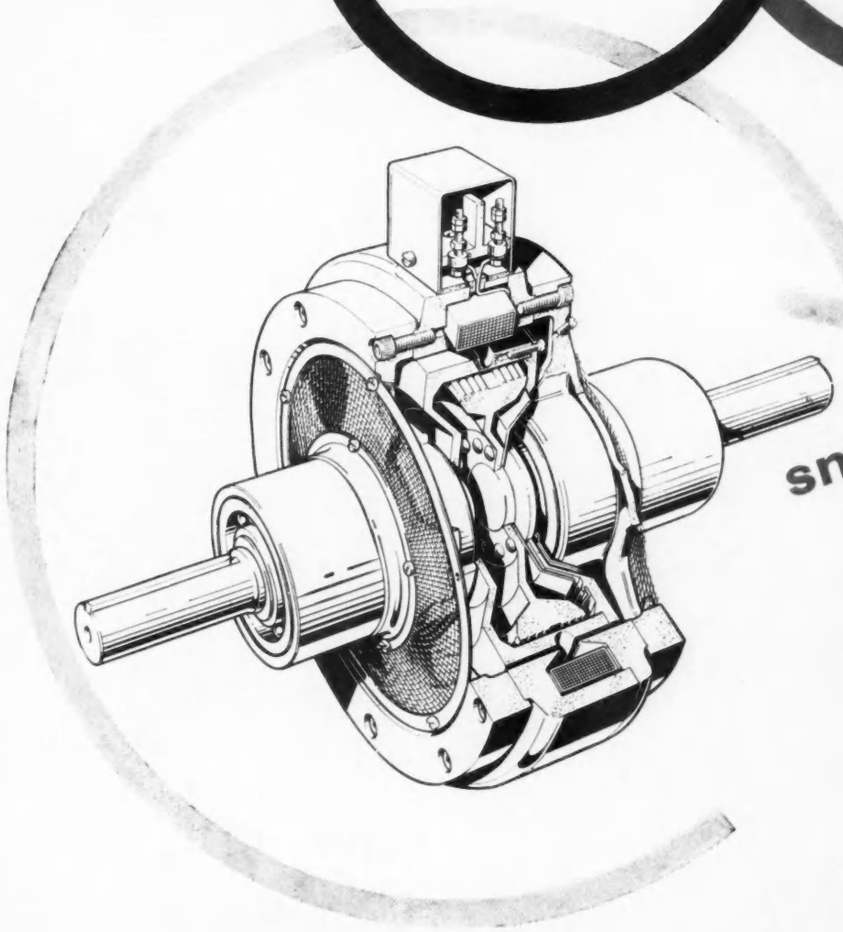

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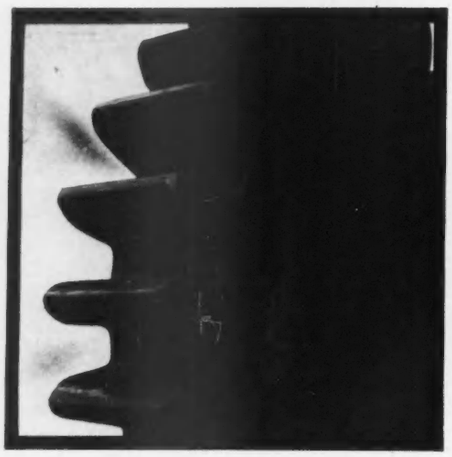

A 25T (5½" deep) Spur Wheel to work at varying centres, reconditioned by the Dilloway method. All teeth built up and machined to correct contours.

A Helical Pinion with Wobbler ends. Teeth built up and machined to correct contours; wobbler ends built up and ground to standard.

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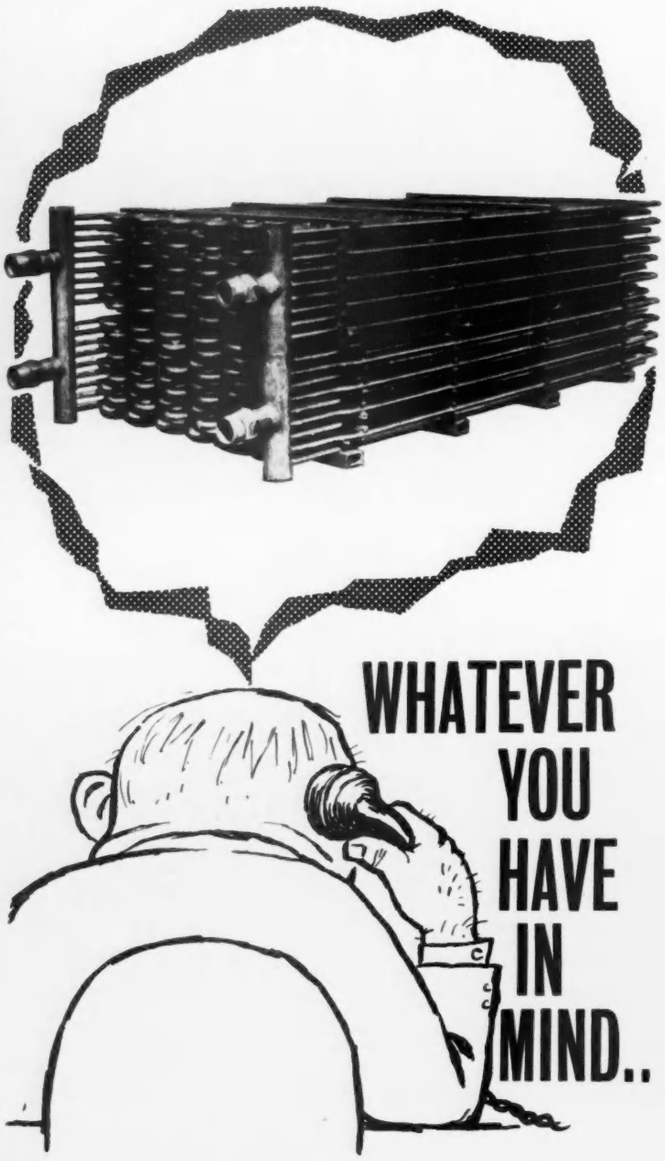

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STRETCH

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PICKLING SHOP *at Appleby-Frodingham Steel Company, Scunthorpe Lincs. painted with Evodyne over Evoled*
Photograph by courtesy of Appleby-Frodingham Steel Company (Branch of the United Steel Companies Limited)

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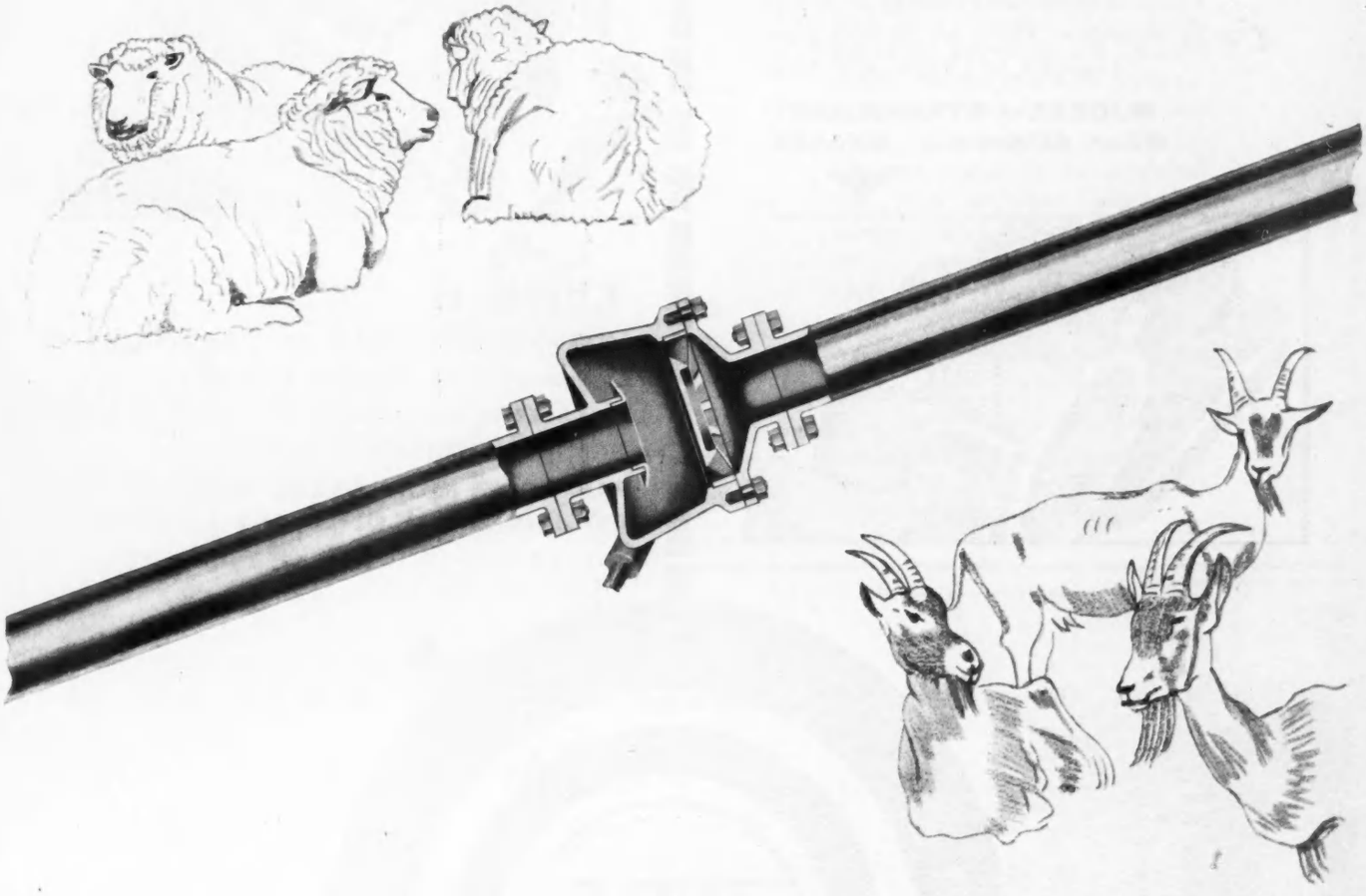
Oil and Water!
it's all a matter of separation



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WITH SEALED BALL BEARINGS

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RUGGED · STREAMLINED
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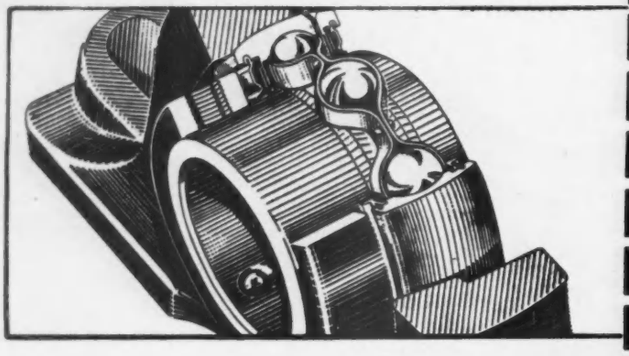

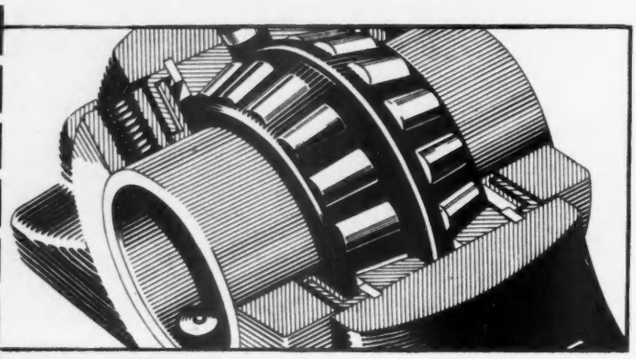

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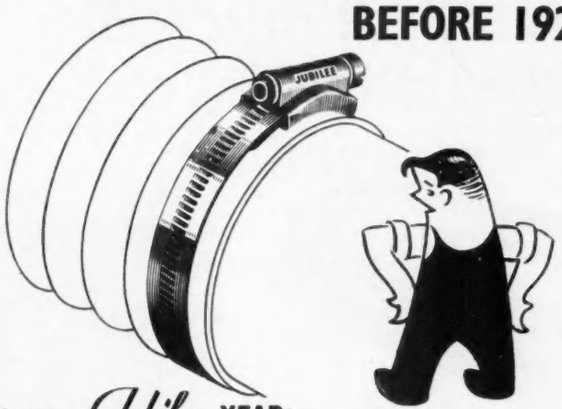

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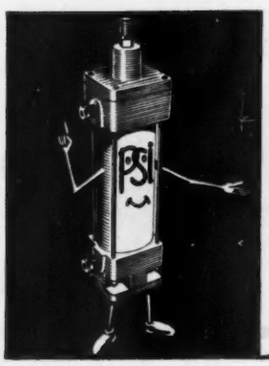

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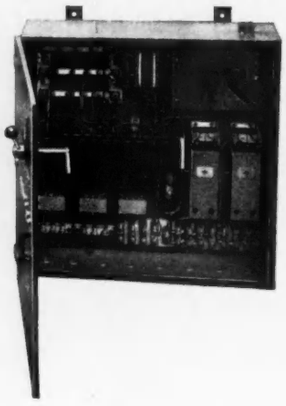
Please send us your enquiries.



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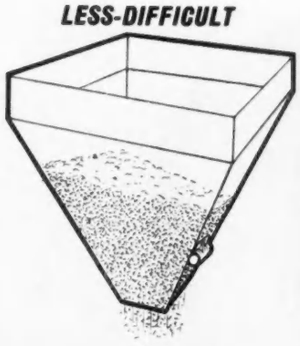
LESS-DIFFICULT



The installation of an external vibrator to a steel hopper.

trouble-free bunker discharge

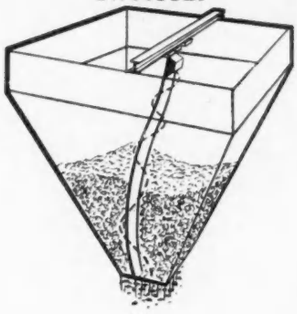
The primitive, inefficient method commonly used for clearing material which sticks in a storage bunker is by applying a sledge hammer to the side of the hopper. This is a form of low frequency, uncontrolled vibration. When vibration is applied at the *correct* frequency, the *correct* amplitude and the *correct* point of application, almost any material can be satisfactorily discharged.

SINEX has the experience with a wide variety of materials and a wide range of hopper designs to recommend how vibration should be applied effectively to solve *your* particular problem.

The three examples illustrated show three different combinations which are typical of many applications, but even these, whilst using the same type of unit, can only be effective if the types of unit themselves are placed in the correct position and have the correct frequencies and amplitudes of vibration to suit the characteristics of the material to be discharged.

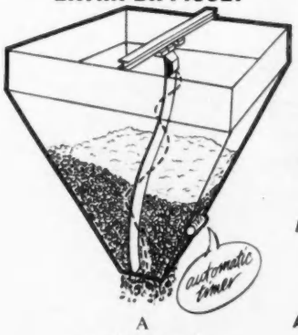
It would pay you, therefore, to make use of our experience and to consult us on your particular problem. Send for relevant details and information sheet.

DIFFICULT

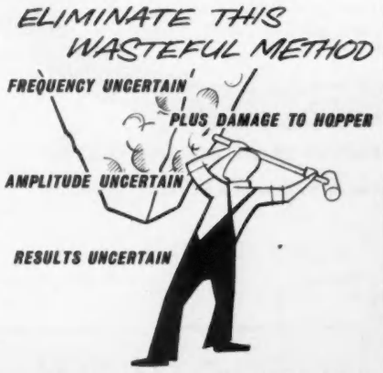


The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.



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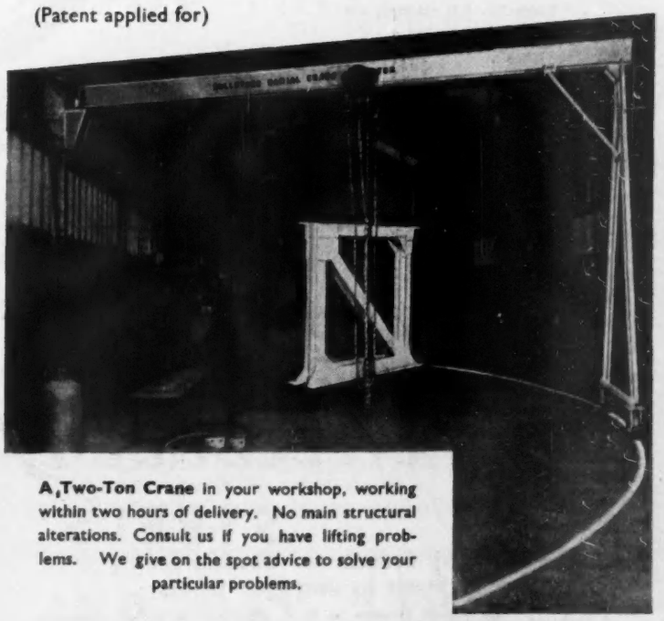
(Patent applied for)



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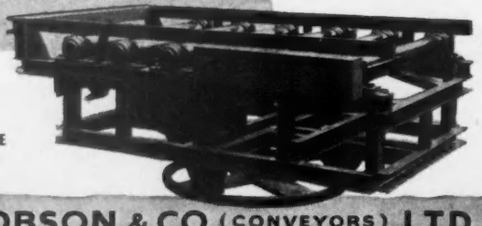

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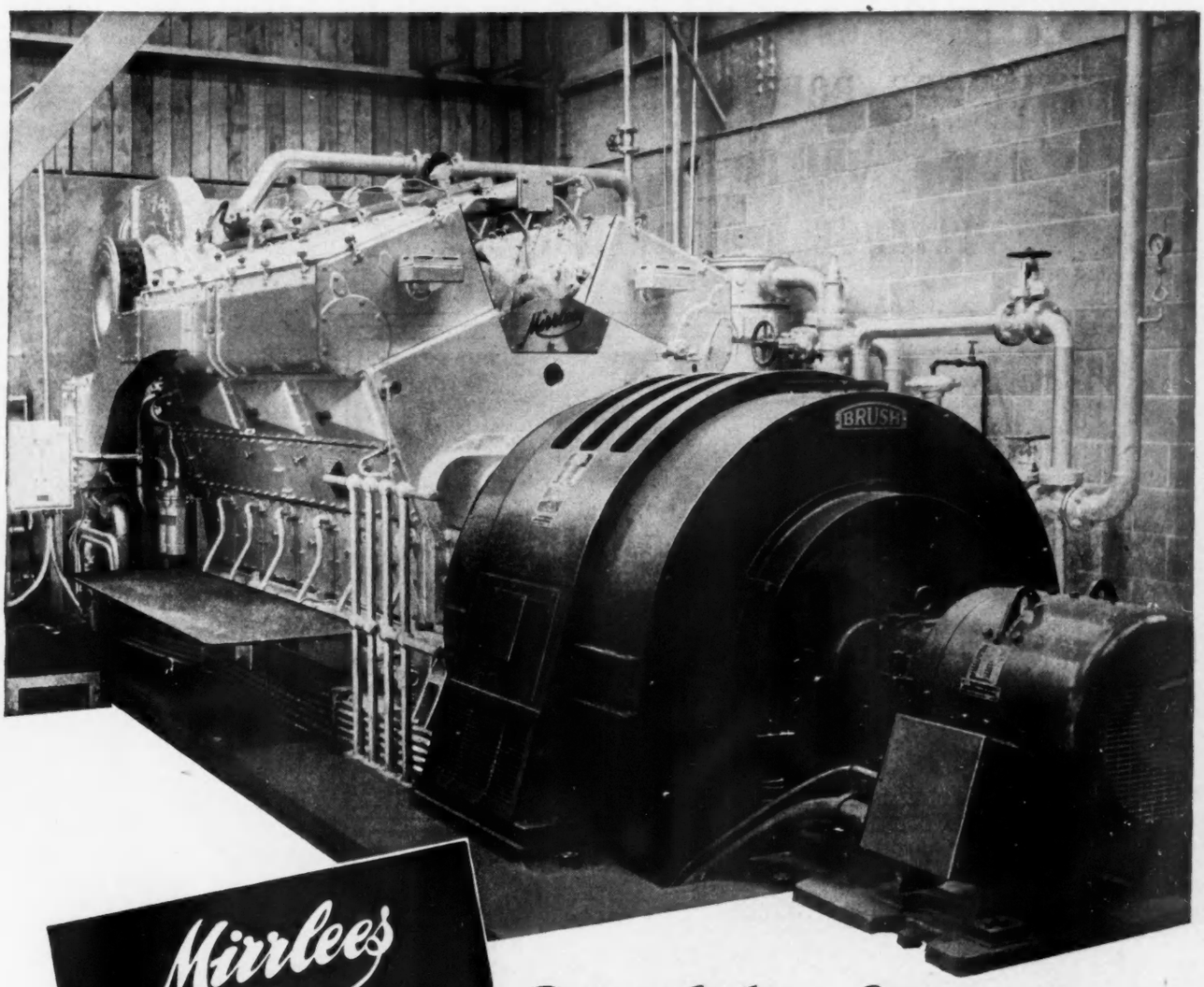

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Where two years ago there was only virgin Canadian forest, there now extends the great Consolidated Dennison Uranium Mine, a 45,000,000 dollar enterprise and the largest uranium mine in the world.

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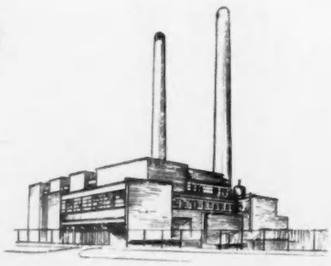
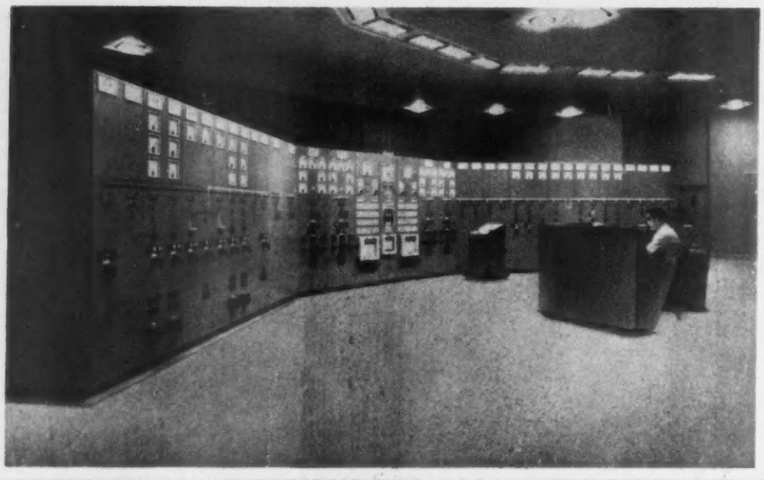
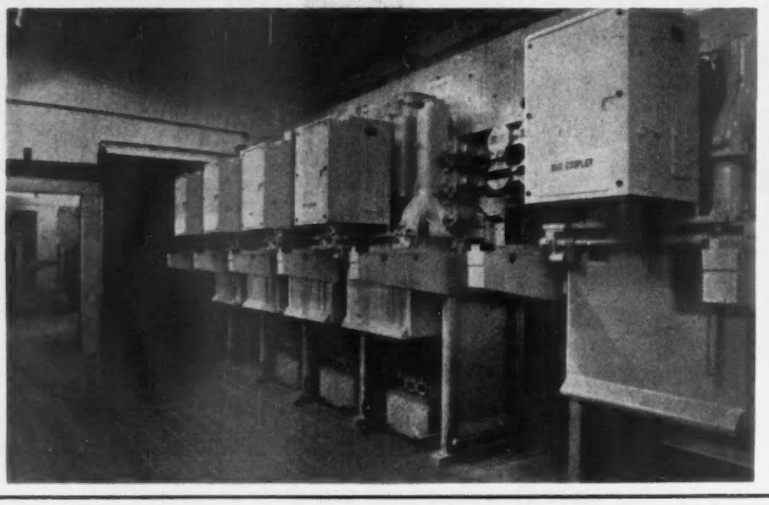
MERSEYSIDE POWER STATION
SWITCHGEAR BY REYROLLE







The illustrations show the main 11-kV 350-MVA oil-break metalclad switchgear and main control-board, supplied by Reyrolle, in the new Merseyside Power Station of Lever Bros. Port Sunlight Limited

Reyrolle

A. Reyrolle & Company Limited - Hebburn - County Durham - England

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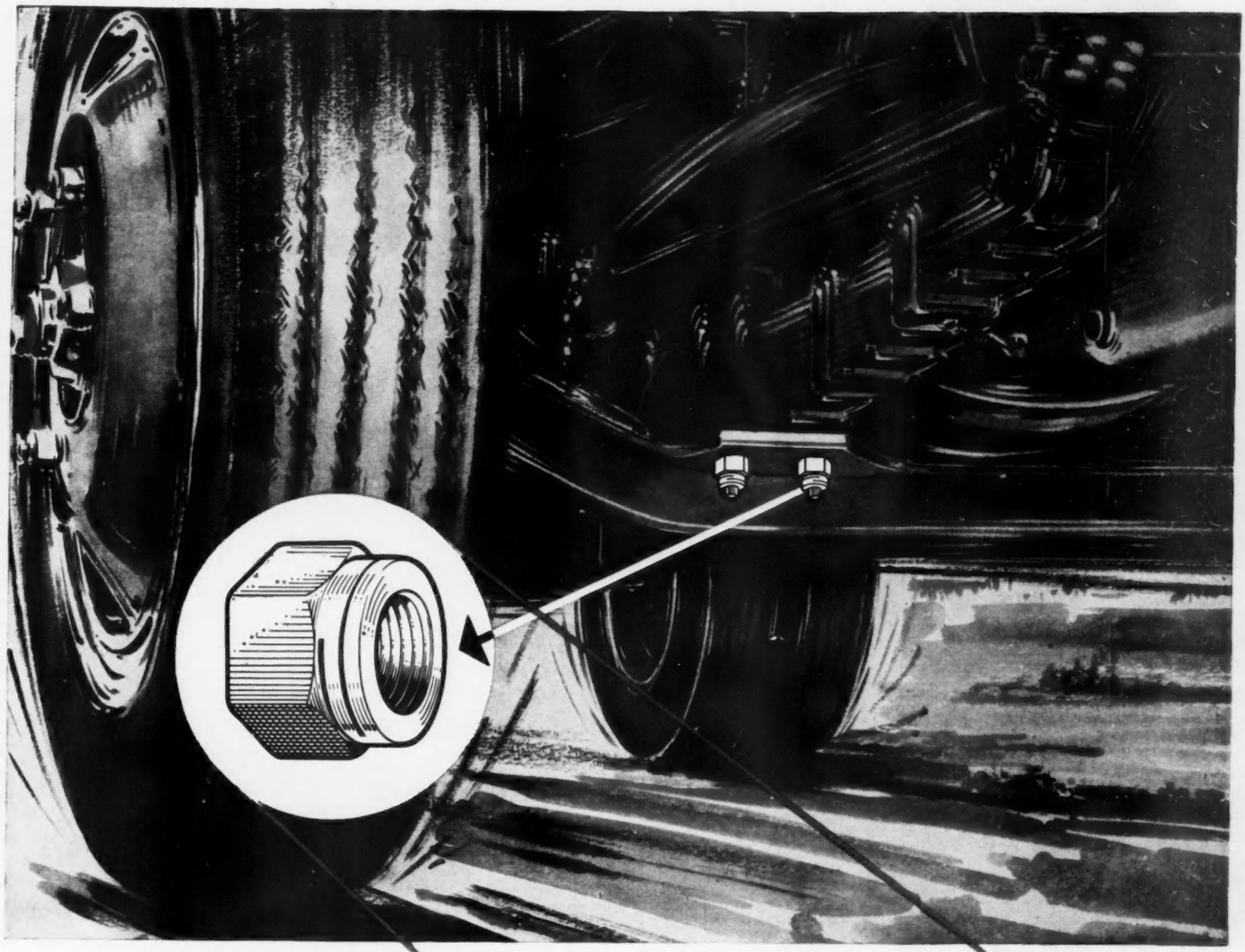

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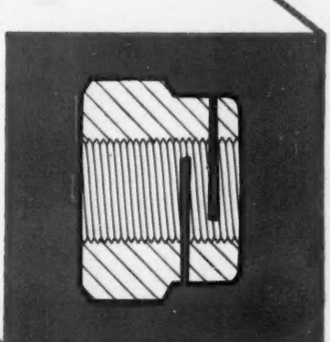

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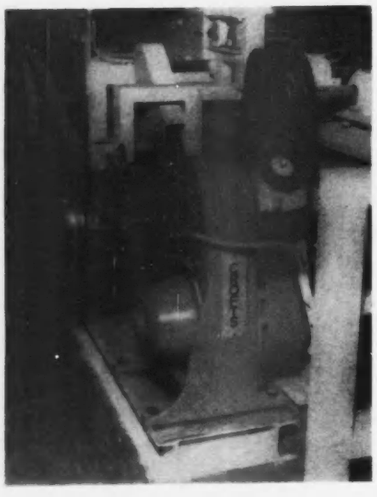

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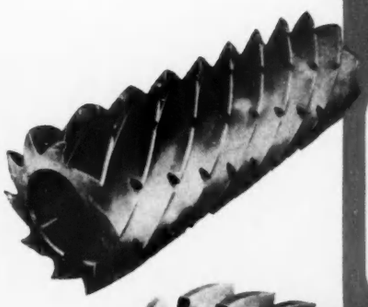

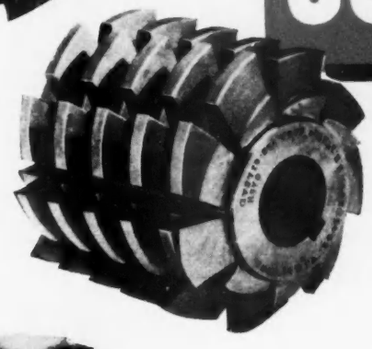

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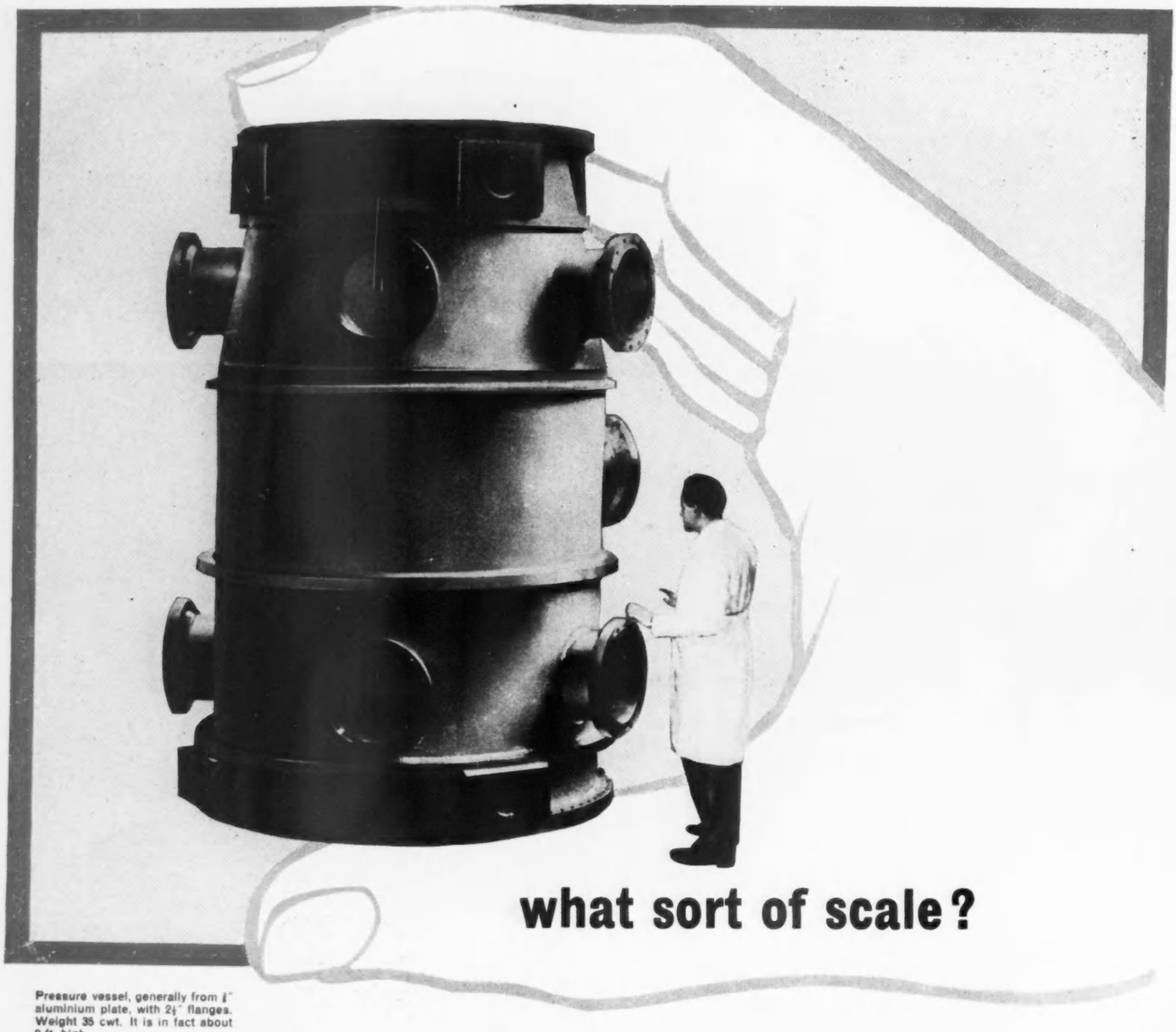

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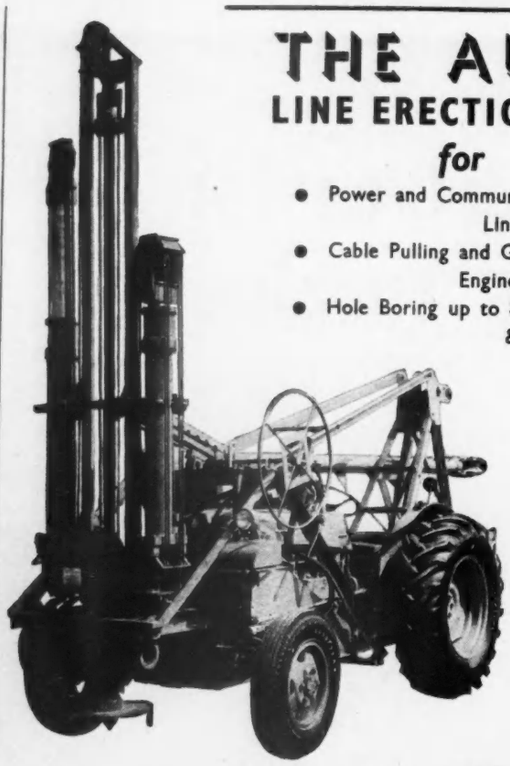

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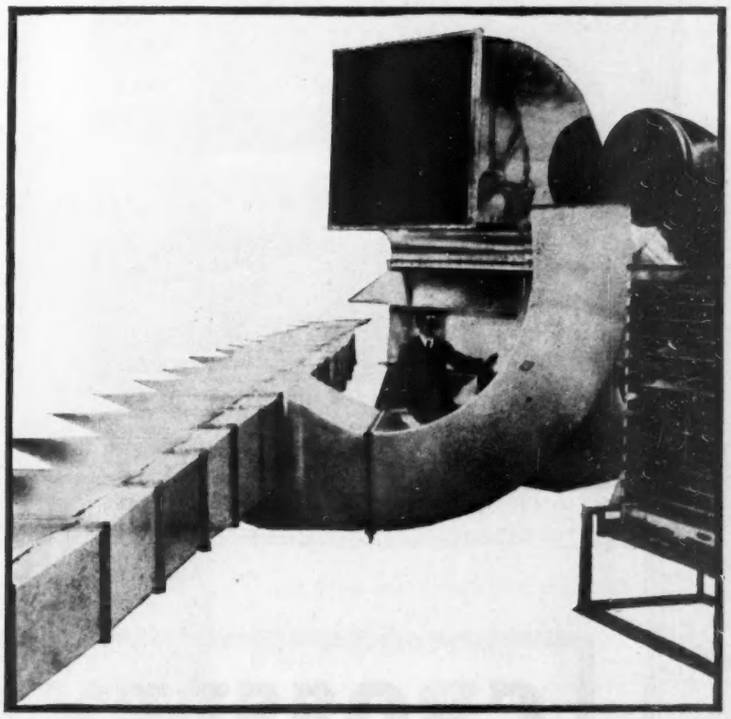

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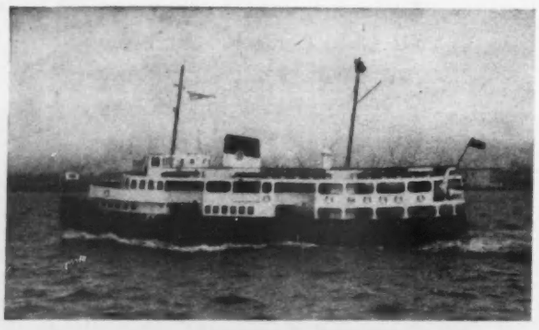

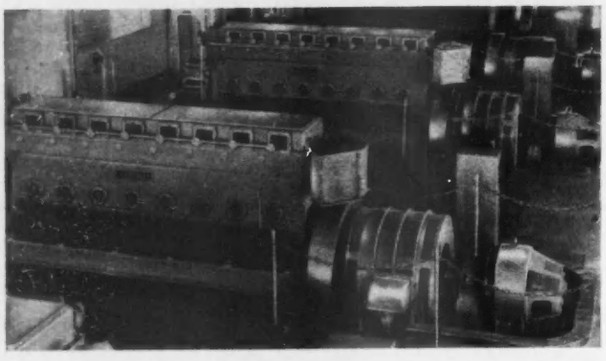

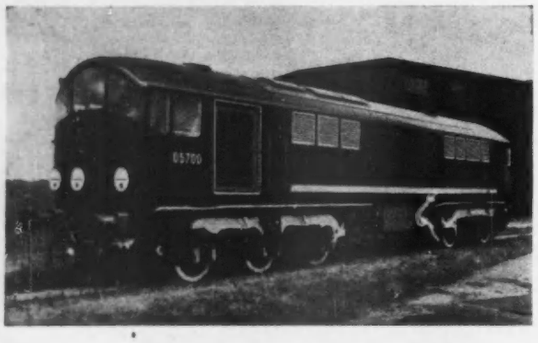

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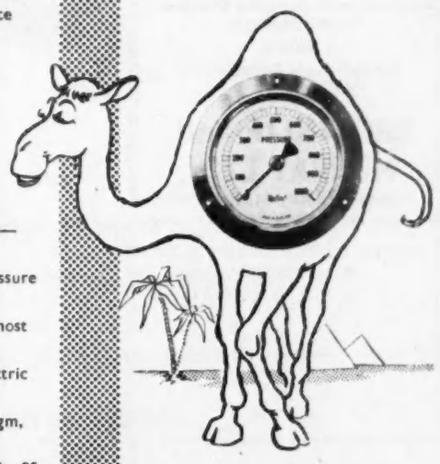

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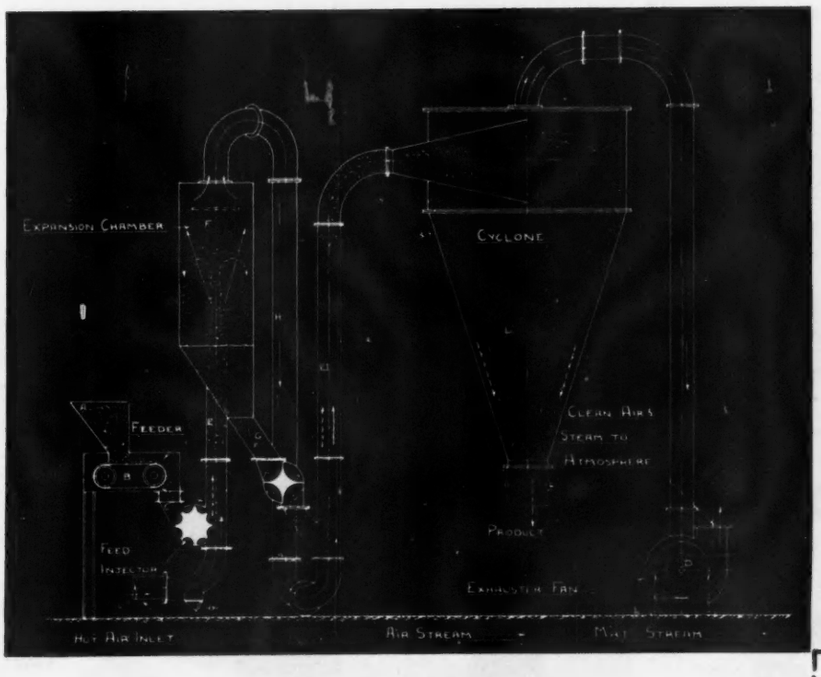

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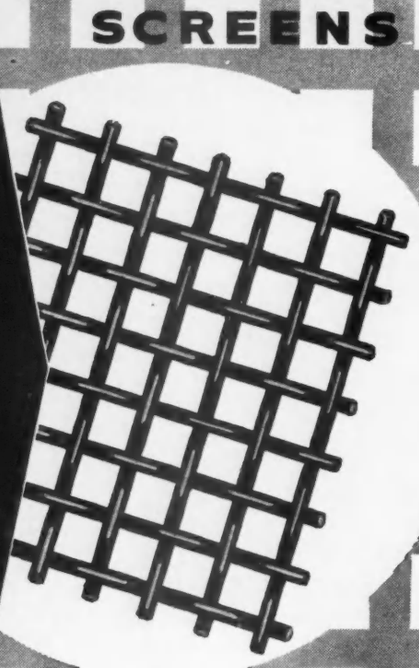

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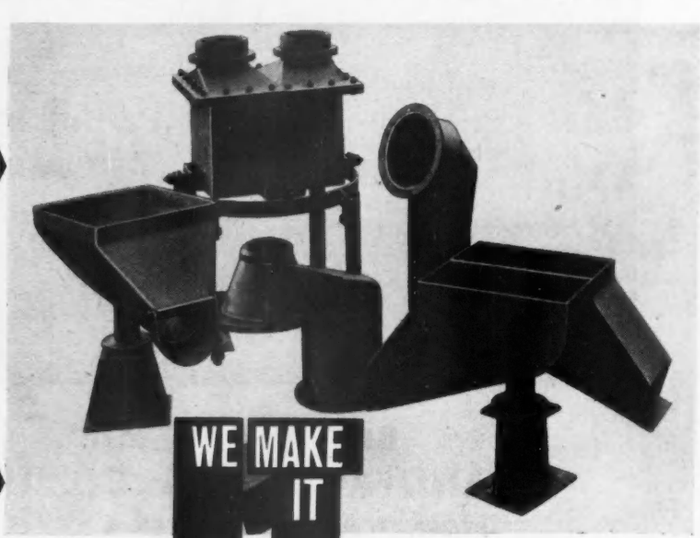

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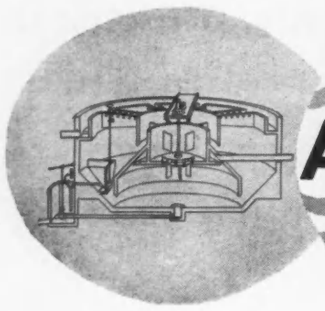

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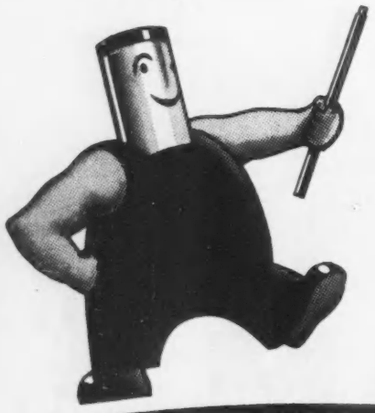

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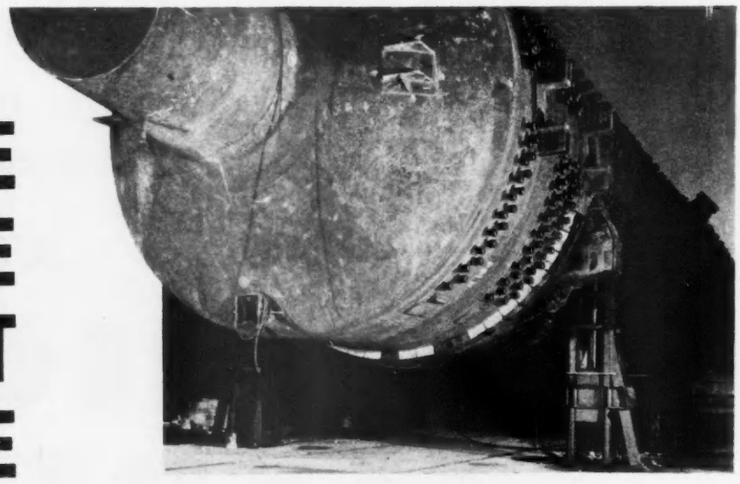

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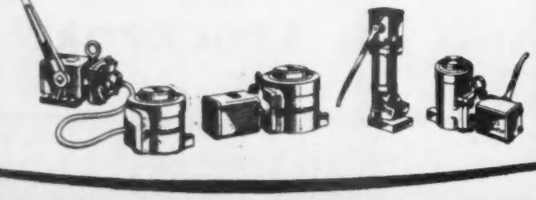

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THE ENGINEER

No. 5434 MARCH 18, 1960 VOL. 209

AFTERMATH OF GUILLEBAUD

We sometimes wonder whether some railwaymen who discuss railway subjects really appreciate what kind of competition the railways of this country are going to have to meet in the future. There seems to stick in the minds of many who speak for railways the idea that they are just as essential to-day as they were fifty years ago and that the country could not continue to prosper were the railways to close down. Up till the end of the last war that was still largely true. It may just remain true to-day. But within a decade or so it is certain it will no longer be true. Just after reading in *Hansard* an account of the Prime Minister's statement last Thursday about the position of the British Transport Commission, in part of which he said : " The life and trade of the nation require a railway system," thereby supporting the idea that railways are essential, we opened a pre-Budget memorandum on " Road User Taxation," sent at about the same time by the British Road Federation to the Chancellor of the Exchequer. Within it was reproduced a table from the paper presented by K. F. Glover in January before the Royal Statistical Society. That table indicates that in 1938 the railways carried 16·3 thousand million ton miles of goods and the roads only 8 to 10 thousand million ; that in 1951 the respective figures were 22·9 thousand million and 18 thousand million and that in 1959 they were 17·7 thousand million and 24·6 thousand million. Industrial production in the meanwhile rose from 70 per cent in 1938 of that of 1954 to 112 per cent in 1959. Quite obviously the movement of goods by road is already much more important than that by rail, though a break-down of the figures into long distance and short distance carriage proves rather more favourable to railways in the former category. But rail transport of goods is clearly of diminishing relative importance. How important will it remain when the system of motorways already planned covers the country ?

In these circumstances we often feel irritated by those who argue the case for railways as against roads. It is claimed, for example, that the railways are ideally suited to the carriage of bulk traffics. Then why is it that certain bulk traffics already go by road ? It is claimed that the railways are not suited to carry small lots. But why not ? The problem, there, is essentially one of sorting. Has not the Post Office been tackling it with substantial success for years ? It is complained, as if it was something unique to railway operation, that the railways have to put up with the peak loads imposed upon them by commuter traffics—just as though electricity supply authorities, restaurant and catering establishments, places of entertainment and almost every kind of body concerned with the activities of human beings does not have to put up with the same difficulty ! Nor, in face of the hundreds of millions of pounds which accrue to the national exchequer every year from motor vehicle taxation (of which less than one-fifth will be spent on the roads in 1960), can we really accept railway arguments that the roads are in some way financially favoured. Indeed, we regard much road-rail argument as largely fruitless. The real situation is that if the railways are to survive they must be able to provide, as the junior, not the senior, partner in the transport set-up, a cheaper or a quicker alternative to road transport or offer some other advantage. Some really hard and cold thinking needs to be done by railwaymen (and by politicians, too) to ensure the existence of such a condition in the future. In a few years' time road transport will have available to it motorways along which lorries and coaches will roll at speeds comparable with those of present-day express freight and passenger trains. Those vehicles will retain that virtue of flexibility which is so lacking to railways, of being able to deliver goods from door to door. If and when motorways penetrate into the centres of cities (as they are already being planned to do) the railways will be hard put to it to beat the roads for speed. The existence of motorways may even make it possible to reduce road transport charges. It is to suit such conditions that railwaymen should be planning the railway system. As we remarked last week, we think that reorganisation for the future must inevitably involve really widespread closing of branch lines, some of which undoubtedly might well be turned into roads. We do not think any general increase of fares or charges fits into the conception. It could only drive more traffic on to the roads, whence it will be very difficult to win it back. The real need is so to reorganise and operate railways that fares and charges can be reduced. Should there not be a reappraisal of the Railway Plan to see whether it now relates railway requirements to the conditions that will really exist in the future ? We have the alarming impression that it may have been originally designed to make railways competitive with road transport as it was before any motorway existed.

On the financial side, in his statement to the House, the Prime Minister could say little as yet, although it is clear from what he did say that implementation of the Guillebaud report will be backed by somehow making the necessary money available on the short term. He did suggest, however, that in some way some of the land assets of the railways should be realised, though whether he was there thinking of closed-down branches or of the quite substantial areas within large cities (closed-down goods yards, for example) we are left unclear. Further relief of the railways from such restrictions as still remain from the time when they were monopolies is something the public will clearly have to accept. Lastly, it is clear that a further degree of decentralisation is to be studied. One M.P., in questioning the P.M., remarked : " the simple problem is that the railways will never pay and that the railwaymen want more money." That, said the P.M., was a " defeatist " view. It is, indeed ! For if there is no means of operating railways without making a loss, then in this small island, the question will very soon be asked, why operate them at all ? That M.P. did

railwaymen and those industries which make equipment for railways no service. He merely gave encouragement to Brigadier Lloyd, who wants to convert the railways into roads !

THE LONDON PLAN

The London County Council has completed the first five-yearly review of its development plan. This review is required by law, but in addition to the formal proceedings, the Council has been at some pains to publicise the review, and to show how much has been achieved in a relatively short span of time and how much more will be done by 1972, which is the end of the present phase of planning. Publicity is well merited, for the plan is an inspiring one, and few people, if any, who know London can fail to be impressed by the scope of the plan and what it will achieve. Nothing like it has been attempted before. Some aspects of this great rebuilding are purely problems in engineering, but to a major extent, it is a somewhat borderline subject professionally, for engineers. Nevertheless, we think all engineers, who, after all, are members of a profession which has more influence than any other in changing the contemporary environment and way of life, will show a lively interest in it. Some of the guiding principles are as follows : Undue growth of offices in central London is discouraged, and more homes are being built in this area. The obsolete " twilight areas " (i.e. a large belt of Victorian property stretching beyond the centre to the outer suburbs of more recent development) are to be made attractive places to live in. Complementary to this, homes must also be provided outside London, in small towns. Much of the rebuilding is grouped into large areas of comprehensive redevelopment, some of them as enclaves or " precincts," as they are called, free from traffic. Individual projects of this kind are quite well known ; generally they show a high standard of planning and architecture. In the East End, planning is grouped into " neighbourhood units." In the Stepney-Poplar area twelve such units are being developed and a " new town " for 100,000 people is gradually emerging from the slums. This is only one example ; there are many others. Ten square miles of London have been rebuilt since 1951, and the present rate of progress is 14 acres per week ; by 1972 £1000 million of public money alone will have been spent on redevelopment, 60 per cent of it by the L.C.C.

In his introduction to the L.C.C.'s report, Mr. Edmonds, the chairman of the town planning committee, emphasises the main problems of congestion and overspill facing the council in the present stages of the plan. He points out that the causes of increasing congestion in London are complex, but are all related quite simply to the strong position London holds both nationally and internationally ; London, he asserts, is the focus of communications of every sort. Those are striking remarks and they magnify one major fault of this great and comprehensive plan, namely, its virtual neglect of road improvements. There are, of course, road improvements in the plan, but, unlike the massive rebuilding of the East End, they are not of the same order of scale as the problem which they are intended to solve, nor can they lay any claim to serve London and increase its prosperity in the way that a " focus of communications " should be served. Mr. Edmonds says : " This is one of the great problems of our time, requiring a balanced solution if we are to avoid motorways and limited access ways cutting like knives through the heart of neighbourhoods and communities." It is interesting to ponder on the contradictions, both rational and emotional, tangled up in this little sentence. A well-known quotation which might have been applied much more aptly to the situation is " urban freeways carry three times the volume twice as fast, at one-fifth the accident risk compared with surface arteries." The London plan is back-to-front, in that one basic " utility "—the fast motor-road—has not been provided for. These roads cannot be " stuck on " to the plan later on. The more of it that is completed without adequate roads the more difficult will the problem become and the more will the roads mar rather than add to the beauty of the town they serve. For ultimately —let there be no mistake about it—they must come.

Present road plans in London are based on the Nugent committee's report, a singularly ineffectual document, which is perpetuating the lag in London's approach to road problems, for just as the London plan leads the country in many other aspects of town planning, so it drags along behind in planning London's roads. The view also seems to be implied that an efficient motor road network in London would make public transport obsolete. " It would be disastrous if the public transport system were allowed to decline," the report states, seemingly implying that this is a reason for rejecting good roads ; yet the M.1 road has inspired a new bus service ! Fortunately there are some indications of a change in attitude which is welcome, if belated. An expanded traffic engineering section is to be set up, and Mr. Edmonds says that traffic engineering research on a scale commensurate with the magnitude of the problem will be put in hand, and links between London and the developing national motorway system must be studied closely, he asserts. But that is all, apart from piecemeal local improvements, up to the present. There is one other notable omission from the planning report. Good housing, open spaces and other amenities, all make a pleasant environment. The state of the Thames will be improved by the new works in progress at the two outfalls. Yet we can find no mention in the report of measures to reduce atmospheric pollution, and to make the air of London fresh and healthy to breathe. Will all these new buildings continue to pollute the atmosphere ? Will the smog and grime of the East End continue to exist after that grim area, as we now know it, has gone ? Others beside the L.C.C. have responsibilities for atmospheric pollution, but the apparent neglect of this subject by the L.C.C. is not a good augury.

AN AMERICAN FIRST IN SPACE

It is very pleasant after having to recognise so many Russian " firsts " in the setting-up of earth satellites and in sending forth lunar and other probes to be able to congratulate the Americans upon one of their own in the field of space exploration. What makes the event even pleasanter to record is the fact that without British collaboration it could not have been done. Last Friday there was launched from Cape Canaveral, in the U.S.A., an object weighing 94·8 lb and 26in in diameter carrying radio equipment which can be switched on and off by impulses transmitted from Jodrell Bank radio-telescope in England. The object has so far behaved almost exactly as predicted and there is no reason whatever for supposing that it will fail to go into orbit, as planned, around the sun in the region between the orbits of Venus and the earth. It is equipped with solar batteries and it is expected that Jodrell Bank will be able to maintain contact with it over distances up to about 50,000,000 miles. Contact is expected to be retained with the object for about 150 days initially, by which time it will have reached the perihelion of its orbit at about 74,000,000

miles from the sun. Thereafter contact will be lost until, in pursuing its orbit, it approaches the earth sufficiently closely for Jodrell Bank once more to receive its transmissions.

The separation of the satellite "Pioneer V" from the three-stage "Thor-Abel" rocket by means of a control signal transmitted from Jodrell Bank was the first step in a unique programme for radio control of a space vehicle. This has enabled a more powerful transmitter than usual to be installed in the satellite, since power is taken from the chemical batteries only for short periods, under the control of Jodrell Bank. Initially, transmissions are taking place for fifteen minutes in each hour, but this will be reduced later to five minutes in the hour, thus increasing the recharge time from the silicon solar cells. Signals to the satellite are received on a permanently-operating receiver which passes them on to decoding circuits. Some ten functions in the satellite, including transmissions, can be initiated by this means. A 5W transmitter similar to those in other satellites is installed, but the main transmitter is of 150W. Appropriate control signals cause them to work independently, or as a combined transmitter, with the 5W unit acting as an amplifier. Measurements of radiation, magnetic fields, meteoric dust impact, and other experiments proceed continuously, the results being stored in electronic memory units. An indication of the aspect of the satellite relative to the sun can be deduced from signals initiated by a photocell device arranged to trigger an electrical impulse when looking at the sun directly. During transmissions, which are made on 378 Mc/s, the accumulated totals are sent first, followed by experiment functions as they occur.

Jodrell Bank has its own radar equipment for many of its normal activities, but in the present instance the ground transmitting and receiving equipment has been supplied by the Americans. Ground-to-satellite transmissions are made in the u.h.f. band, and a peak pulse power of 10kW is available. The receiving equipment includes parametric amplifiers. Experiments of this kind with control transmissions into space suggest many applications as the age of space exploration comes nearer. We understand, also, that new equipment is being provided to carry further the tests of ordinary communication by reflection from a satellite which began last year with a 1kW transmitter of Pye Telecommunications, Ltd., working on 201 Mc/s.

IN MEMORY OF GRAHAM CLARK

It is a remarkable thing that the Graham Clark lectures, an abstract of the sixth of which we reprint elsewhere in this issue, have already acquired a firm character of their own. The original intention—not very inspired—was that each should be on a subject of common interest to the members of the Institutions of Civil, Mechanical and Electrical Engineers. Now one can think easily of a number of technical fields, for example, hydro-electric power development, railway modernisation, &c., which, treated broadly, would interest engineers over a wide range of training and experience. It would not, therefore, have been at all surprising if those who were asked to lecture had chosen such subjects. In fact, however, something has happened which would, we think, have delighted the heart of the late Mr. Graham Clark. (Do we need to remind readers that he was for many years the deeply honoured secretary of the Institution of Civil Engineers ?) The lecturers, chosen, perhaps, with the deliberate hope that they would do so, have turned aside from technicalities ; and the lectures are becoming associated with the discussion of the work and education of engineers within our twentieth century civilisation. The latest lecturer, Sir Hugh Beaver, emphasised how the character of the lectures had formed itself. "Intentionally or unintentionally," he told his audience, "you have moved from what was the original purpose ; and in this you have been completely right."

The subject the lecturers are opening up has innumerable facets. One of those facets is, of course, the divorce between the sciences and the arts which has been so much under criticism lately, which is so open to criticism, but which, in an age of specialisation, it is so difficult to destroy. Another facet lies in the contrast for many people between the dull uniformity of work and the variety of new experiences that higher salaries and wages open before them in their leisure time. Should work and play be so sharply differentiated ? Still another facet lies in the disturbing impact of high rates of material advance upon thinking in certain fields more used to a moderate pace. Some architects, for example, regard with abhorrence the idea of motor-roads cutting through the hearts of great cities ; and even speak of "disciplining" people not to bring their cars to work. Surely the right solution, difficult though it may be to find it, is to make the motor-road an essential constituent of the beauty of the city ! Much the same problem needs to be solved in the building of, for example, nuclear power stations in lonely places, which surely need in no way desecrate their surroundings. But perhaps the major factor to be stressed is that no artist nor humanist who attempts to eschew some appreciation of science, nor any practitioner within pure or applied science who neglects to acquire some appreciation of the arts and humanities can possibly lead as rich and full a life as has become possible to man in this the twentieth century.

The Engineer—100 Years Ago (MARCH 16, 1860)

"ROAD MAKING"

"In addition to the cost of all our turnpike roads, we are spending upwards of two millions a year on our highways. The cost of our roads as a whole, is, therefore, something enormous . . . A broad view of the question of roads shows that we have now arrived at a period in our social necessities when a general assimilation of modes of management, and a consolidation of the separate interests existing, are absolutely needful . . .

"Now that we have spent twenty years in the development of a new system of communication, to which the old is a humble subsidiary, it does seem time that our attention was recalled to what is of vast secondary importance, though no longer of prime moment. We need a broad and judicious assimilation of our general road management, that shall secure comparative efficiency, as much in the present highways as in the turnpikes. We need an efficient central oversight of some kind or another, that shall secure consistent and harmonious working through every ramification of the system, and a responsible management circulating to the remotest nooks and corners of the land, whose delinquencies cannot be screened. We want a guarantee that money shall not be wasted on ignorant quackery, and local experiments on modes that have been exploded over and over again in more intelligent quarters, but that shall guarantee the greatest result that the aggregate experience of roadmakers can afford for a given outlay. Such a movement would carry the quickening influence consequent on easy and rapid intercommunication to the remotest corners of the land, and give an impulse to general material development tenfold repaying the outlay it would occasion."

Engineering and Civilisation

By SIR HUGH BEAVER, K.B.E., M.I.C.E., M.I.Chem.E., M.E.I.C.

The origin of the Graham Clark lectures lay in the idea that an annual lecture should be given on a subject of common interest to the members of the Institutions of Civil, Mechanical and Electrical Engineers. In the sixth such lecture, delivered on March 3 at the Institution of Electrical Engineers, of which we print below some short extracts, the lecturer pointed out that the five preceding lectures had tended to have an even wider front than that covered by the membership of the three institutions and that the subject under discussion had tended to become that of engineering and civilisation. He reviewed what was said in the first five lectures and related it to what other commentators have said on the subject from time to time and with special relevance to education.

IT is not only in engineering that specialisation and fragmentation are to be seen ; it is probably a characteristic of all science. But it is by the nature of things most marked in engineering ; and the result unfortunately must be to weaken, or deflect, or conceal, the conscious influence and impact that engineering has and should have on society and on civilisation. For this is an age in which science and technology are inevitably having an ever-increasing influence on our lives as individuals, on this country's position and power, and on the whole world.

It is essential that science and scientists and technologists should accept this and realise all that it means ; it particularly falls to the engineer, the applier of science, to see himself as part of a service to mankind and to condition his thinking accordingly. Thus, it is that it is one of our greatest problems to see how in spite of specialisation in so many directions we may still recognise and hold a common purpose and an ultimate worthwhile objective as being the real heart and justification of all engineering effort.

It is in this context and against this broad and perhaps rash concept of all that engineering is and could be, that I approach this lecture.

The greatest danger that we face in the world to-day is, I believe, that science and technology should not realise or should ignore what they owe to humanity ; and that the arts, whatever that is taken to cover, should seek to or seem to maintain, wittingly or unwittingly, the wall that from time to time—but not always—has been erected round them. We cannot afford and we cannot risk this division between the so-called humanities on the one side and science on the other ; and it is in my opinion wholly meaningless.

The Lectures as Chapters

Many of you may have heard all the five previous Graham Clark lectures at the time, or have read them subsequently. But perhaps not many have read them as a whole as I have recently done and as I would recommend to you. They were :

The first : Sir Harold Hartley on " The engineer's contribution to the conservation of natural resources."

The second : Sir Maurice Bowra on " The impact of engineering on society."

The third : Sir Ifor Evans on " The place of engineering in university education."

The fourth : Sir Ewart Smith on " The engineer and management."

The fifth : Sir Arnold Plant on " Engineering in an expanding economy."

I shall refer to some of them in more detail later, but I have given you the titles because I want you to see them as part of a single picture that is being painted, for which you have called on minds from other disciplines than engineering to contribute ; indeed, only one of the five lectures was delivered by an engineer. Intentionally or unintentionally, you have moved from what was perhaps the original purpose ; and in this you have been completely right.

My object is to try to put into perspective these lectures in the wide field of engineering thought and achievement and attempt ; and from this to encourage you to project your own minds forward to envisaging the duty of the engineer in the new world and the future that is so rapidly developing in front of us. I must at the outset reiterate my conviction—and I am sure it is yours also—that these are momentous times.

The Riddle of the Sphinx

I do not think that anyone questions that engineering has continuously throughout history improved the standards and conditions of living, until now we have reached the present position when, to quote Sir Ewart Smith, " the advance of science and its practical application through engineering and chemical technology has shown that mankind has the potential ability to achieve any standard of material wellbeing that may be desired." That is a great claim on behalf of engineering.

What more then is it that we require from engineering ? " Where," answers Sir Maurice Bowra, " the engineers have gone wrong is . . . that they have set out to improve the human lot—and have assumed that this just means the greater exploitation of natural resources for the benefit of humanity." And more positively Sir Ewart Smith again adds—but speaking in the rather narrow context of management—" our own civilisation can continue successfully only if it achieves a balanced combination of the humanities and technology, based on both science and art."

This is no new criticism or suggestion ; it is one continually being made now. But if you go far enough back you will not find it being made, because there was no need to do so. It is the result of our age of specialisation. To Leonardo da Vinci and to those who flamed in the sky of the wonderful Renaissance, in our own Elizabethan age and indeed even later when the Royal Society was born, there was not this distinction between culture and art and science and engineering.

I think it is not inappropriate here to recall to you Bacon's pleasing use of the Sphinx's riddle in that series of mythological fables that he called the " Wisdom of the Ancients," because, as he wrote, " upon deliberate consideration my judgement is that a concealed instruction and allegory were originally intended in many of the ancient fables." " This riddle of the Sphinx," he says, " is an elegant, instructive fable, and seems invented to represent science, especially as joined with practice. For science may, without absurdity, be called a monster ; her figure and form is varied by reason of the vast variety of subjects that science considers ; her voice and countenance are represented as female by reason of her gay appearance and volubility of speech . . . ." " Sphinx is said to propose various difficult questions and riddles to men which are harmless and entertaining for contemplation and enquiry so long as there is no other end but knowledge. But which as soon as they are put into practice, which urges and impels to action, choice and determination, then it is that they become torturing, severe and trying and unless solved and interpreted strangely perplex and harass the human mind, rend it in every way and perfectly tear it to pieces. All the riddles of the Sphinx therefore have two conditions annexed—dilaceration to those who do not solve them, and empire to those that do . . . Sphinx has no more than two kinds of riddle, one relating to the nature of things, the other to the nature of man—and the prizes are two kinds of empire—the empire over nature and the empire over man."

Is not this just what faces us to-day ? May not this perplexing, harassing problem perhaps really be part or all of the explanation of some who have not been able to distinguish between their duty to their country and their duty, as they have seen it—a perverted view no doubt—to mankind. Such thoughts undoubtedly swayed some at any rate of the nuclear traitors—the Nunn Mays and Fuchses and Pontecorvos of our country. Some such anguishing dilemma torments at least some of those who march to Aldermaston or camp outside aerodromes to show their disapproval of atomic bombs.

These are problems that as Bacon says mean dilaceration to those who do not solve them ; and these are not the physical and chemical problems which in the end will always be solved but the problems that follow thereon in regard to their impact on mankind, which unless we solve, we must face the extinction of civilisation and perhaps of mankind. That is the problem of all, but particularly of scientists and technologists and engineers.

Readjusting the Balance

In a paper which Professor Baker, the Head of the Engineering Department at Cambridge, read some three years ago at the Summer meeting of the Institution of Mechanical Engineers he ended as follows :

" Turning towards the future, there will be further developments in our treatment of the physical sciences and their application, but first we are likely to see growth in studies related to management. Technical engineering takes place in the social and economic environment of industry, and it seems to us desirable to introduce students to the growing body of knowledge concerned with this environment. Many places have experimented with courses of arts lectures designed to help the technologists towards a fuller and richer preparation for life. We do not consider this ' top dressing ' necessary here in a residential university, but we have, for many years, included courses of lectures on management problems, industrial psychology, and industrial relations. There is, too, room for a new group in the Part II Tripos course, so that men could spend a year on the study of human relations and other management topics rather than on the physical subjects offered by the other groups. There also seems no reason why, if extended successfully into other manage-

ments fields, a third post-graduate course of instruction should not be instituted in the more distant future."

In the Report of January, 1959, to the University of Cambridge by the Faculty Board of Engineering, there occurs this :

" Since the beginning of 1957 the Board have caused a study to be made of management education in the United States of America and elsewhere, and they have sought advice from members of other Faculties in the University, from industry, and from other interested bodies. As a consequence of this study, and from the experience gained in the Department of Engineering from teaching management subjects for the Examination in Engineering Studies, the Board are satisfied that there is a sufficient body of knowledge and that teaching can be of a sufficiently high standard to justify the introduction of teaching in management at a standard comparable to a Tripos."

And as you probably know there has now been introduced at Cambridge a one-year course for an examination in the principles of industrial management in which for instance there will be five papers, of which two will be on human behaviour in industry and on the social environment of industry. The other case I quote is the joint action for some years past of the Imperial College of Science and Technology and the London School of Economics and Political Science to provide a scheme of joint graduate and post-graduate studies in technology, economics and administration.

Both these approaches, i.e. the Cambridge and the London, are experimental and they are largely influenced by and aimed at the problem of industrial management. They may in time give birth to a full course in management, in exactly the same way that engineering in the United States was the mother of management as a university subject and discipline. The recent Crowther Report, too, deals at length with these problems of the production of men and women who can comprehend the impact upon society, and the " corollary that scientists and technicians should be exposed to the radiation of humane letters." But it must inevitably be questioned whether any such approaches go far enough. Certainly they go very little of the distance to the goal that I have in mind, where science and its application are themselves the basis and means of a humanistic education, the new civilisation.

As long ago as 1867–68, in giving evidence to the Parliamentary Select Committee on Scientific Instruction, Huxley challenged the whole concept of university education as it then was. " The universities," he said, " make literature and grammar the basis of education ; they actually plume themselves upon the outside of the fabric." " Now that in my apprehension," he went on, " is not real culture, nor is it what I understand by a liberal education. The thing you really have to do is, in my opinion, to invert the whole edifice and to make the foundation science, and literature the superstructure and final covering !"

We might dismiss all this—as no doubt it was dismissed—as the costive words of an irritable individual ; but quite recently Sir Eric Ashby, in the lectures to which I have already referred, has returned to the charge in very similar though not such provocative words. He quotes from Whitehead's *Science and the Modern World*, published in 1927, as follows :

" There is something between the gross specialised values of the mere practical man and the thin specialised values of the mere scholar. Both types have missed something ; and if you add together the two sets of values, you do not obtain the missing elements. When you understand all about the sun and all about the atmosphere and all about the rotation of the earth, you may still miss the radiance of the sunset. There is no substitute for the direct perception of the concrete achievement of a thing in its actuality . . . A factory with its machinery, its community of operatives, its social services to the general population, its dependence upon organising and designing genius, its potentialities as a source of wealth to the holders of its stock is an organism exhibiting a variety of vivid values. What we want to train is the habit of apprehending such an organism in its completeness." And then Sir Eric proceeds to comment as follows :

" The habit of apprehending a technology in its completeness ; this is the essence of technological humanism, and this is what we should expect education in higher technology to achieve. I believe it could be achieved by making specialist studies (whatever they are : metallurgy, or dentistry or Norse philology) the core around which are grouped liberal studies which are relevant to these specialist studies. But they must be relevant : the path to culture should be through a man's specialism not by by-passing it."

Well, that is brave thinking (although I am not sure that Huxley is not nearing the truth) ; and unfortunately, as Sir Eric Ashby recognises, and as all others who have studied this problem have realised, anything like this would require at least another year at a university. The Rector of the Imperial College of Science and Technology, Sir Patrick Linstead, in his Hinchley Memorial Lecture to the Institution of Chemical Engineers in 1957, took the same subject, " Education for our times." " Should scientists and engineers be taught non-scientific subjects at the university ? " he asked, and went on " This last question goes very deep. The particular question which I should like to ask is how far we can help students of science and technology to acquire a broader education and the attributes of leadership during their university career. This is not a problem for the university alone. It is a general human problem . . . Neither is this a problem peculiar to scientists and engineers. Many scientists are certainly narrow specialists, but for complacent ignorance of vast tracts of human knowledge they cannot claim to excel many of their arts colleagues."

" Let us, however," he says, " return to the immediate question, which is what can the universities do for their students of science and engineering." In the first place Sir Patrick Linstead considers the proposition that time should be found for the liberalising process by extending the length of the bachelor course both in science and engineering to four years, which would put us nearer the position in almost all other countries in the world. This, entailing as it must an immediate capital expenditure of perhaps £20,000,000 and a hiatus in output of upwards of 7000 men for one year, would he finds be quite impossible in relation to the country's urgent needs.

He concludes eventually that there is no room for the introduction of compulsory and examinable non-scientific subjects into a three-year first-degree course and that all that a university or a college can do is to make a continuous and organised effort to provide facilities whereby a student can broaden his outlook, interests and experience. There could, in addition, he thinks, be certain kinds of non-scientific study which arise directly and as it were functionally out of a man's vocational interests which could be properly studied as part of them, or side by side with them. He instances the learning of Russian or of economics or of the history of science and technology.

You will see how much thought is being given by many educationists to the problem of producing the adequate citizen for the new world, for furnishing citizens who can deal with the problems of a scientific world whether they approach them from the side of arts and the humanities or from the side of science and engineering, but in particular to produce the scientist and the engineer as fully educated citizens of their country and of the world.

But how much thought is being given to it by engineers themselves ? The engineer is responsible for all the physical basis and development of civilisation ; it is he who sooner or later translates into action every discovery of science ; he lives much closer to life as it is lived by the ordinary man than does the scientific researcher. Here then are both his responsibility and his opportunity.

Here, too, we have another aspect to be considered. Engineering has never, as Sir Maurice Bowra sees it, been revolutionary in the political sense. " If we regard politics as the struggle for power, engineering is," he says, " not a political activity." I think it would be difficult to be quite certain that this has always been so ; but by and large I believe we must accept the charge. But no one has the right to disclaim or " opt out " of politics, least of all the engineer. The Greeks had for such a one—as for other types—a name. They called the citizen who took no active interest in politics—a private person—an ἰδιώτης. Hence our word idiot.

Is this then not something to which the great institutions should give continuous—and not just occasional—thought ? They have in their combined membership a great body of practical people. Education goes on all through one's working life, and if it seems difficult—although I personally do not accept this—to see how schools and universities can at the same time produce in the same person both the specialist and the man of wide vision, then is it not possible for the institutions to see how far they can in part at least rectify this omission in the post-university life—in the working life ; looking on themselves not solely as platforms for technical discussion but as providing the means of studying how there can be greater contribution by engineers of the future to the civilisation of the future ?

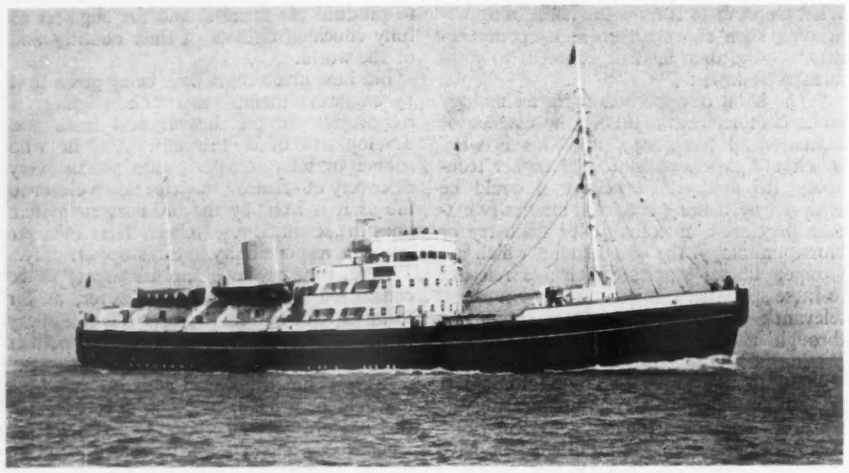
If I may make one final quotation—from the Second Graham Clark Lecture, Sir Maurice Bowra's—it is this :

" As the Greeks said ' even the gods do not fight against necessity,' and for us engineering has become a necessity. It has brought untold benefits to the world, and if it has often enough been held responsible for our catastrophes, it is we, and not it, who are to blame. I even cherish the hope that it may help to solve some of our political troubles . . . Man's unique position in the scheme of things lies in his ability to turn nature to his own ends, and if he really knows what these ends are, he should be able to do on an ever extended scale what he has already begun to do with such imagination and devotion and skill."

That is a testimony to what engineers have done, but it is even more a warning of what they have to do ; and that will not be achieved by one Graham Clark Lecture a year. We have much more to do.

Lighthouse Tender Motorship "Siren"

The M.V. "Siren" has been specially designed for servicing lighthouses and lightships and maintaining buoys and is destined for service at Cowes to replace "Beacon." Built by J. Samuel White and Co., Ltd., for the Corporation of Trinity House, the ship measures 205ft 5in by 37ft 6in by 23ft 6in depth to upper deck, and is propelled at 13 knots by diesel-electric machinery built by The English Electric Company, Ltd. The machinery consists of four 292kW diesel-driven generators and two 725 s.h.p. propulsion motors.



THE second of three lighthouse tenders, M.V. "Siren," which were ordered by Trinity House from J. Samuel White and Co., Ltd., Cowes, Isle of Wight, has recently been completed and handed over to her owners following successful trials. This twin-screw diesel-electric lighthouse tender, shown on trials in our illustration, is intended for district tender service for servicing lighthouses, lightships and maintaining buoys. The main particulars are :

Length overall	221ft
Length between perpendiculars	205ft 5in
Breadth moulded	37ft 6in
Depth moulded to upper deck	23ft 6in
Draught	13ft
Speed	13 knots
Gross tonnage	1425
Complement	41

Models were tank tested, to determine resistance and manœuvrability, at the N.P.L., Teddington, before deciding upon the hull form finally adopted. There are two complete steel decks, upper and main, and a steel lower deck forward and aft of the engine-room, and six watertight transverse bulkheads forming the main subdivision. Welding has been largely used for the joining of plates, while the frames, beams and stiffeners have been generally riveted. Forward of the propelling machinery, which is arranged well aft of 'midships, are the oil tanks which have a total capacity of 200 tons and are subdivided longitudinally into four compartments. There is a pipe tunnel on the centre-line with overflow tank below. A double bottom is worked forward and divided into five tanks for the carriage of fresh water, for which additional capacity is provided in wing tanks in the main hold, to make the total capacity 150 tons.

On the upper deck is a long deckhouse and above is the boat deck with a deckhouse at its forward end surmounted by bridge and upper bridge decks. In the house on the boat deck is the captain's suite and three spare cabins, while the deck and engineer officers have their cabins on the upper deck. The officers' lounge and dining room and crew's mess rooms are 'midships on the main deck and aft on the same deck are crew's cabins. Accommodation for the seamen and engine-room staff is located 'midships in the lower deck and aft of the engine-room are the living quarters of the ten lights officers and twenty-one lightsmen. In addition to natural ventilation, there are two "Maxcess" axial flow fans providing mechanical ventilation, while heating is by hot water radiators.

By reason of its service, special deck machinery, supplied by Clarke Chapman and Co., Ltd., is fitted and includes an electric towing winch which is mounted aft in the house on the upper deck. Power is provided by a 30 h.p. motor and the winch barrel takes 120 fathoms of 4½in steel wire rope. There are two warping ends fitted outside the house on an extended shaft and the winch is rated to wind in at 60ft per minute against a pull of 5 tons and to withstand a maximum rendering strain of 15 tons, while an automatic device ensures a balanced load. Right forward is a triple-headed capstan, for lifting anchors and buoys, each head separately driven through a slipping clutch from a 48 h.p. motor, controlled by a 75kW booster set, sited on the main deck. Each capstan barrel is capable of a pull of 10 tons at 35ft per minute and a slack rope speed of 150ft per minute. A single-head capstan having the same duty is also fitted on the fore deck. For lifting buoys there is a 15-ton derrick mounted aft of the foremast and powered by two electric winches, one for hoisting and the other for topping. Each winch, powered by a 48 h.p. motor, can accommodate 140ft of 4½in steel wire rope and is capable of exerting a pull of 10 tons at 38ft per minute. At the forward end of the deckhouse are two warping and guy capstans, each driven by a 9 h.p. motor on the deck below and rated to have a pull of 30 cwt at 50ft per minute or 10 cwt at 150ft per minute. Mounted on the front of the deckhouse to port and starboard are 5 cwt light vessel relief derricks.

Steering of the ship is effected by trunk piston pattern gear, provided by Brown Brothers, Ltd., and having two electrically-driven V.S.G. pumps and each capable of moving the rudder from hard over to hard over in thirty seconds at full speed, or in eighteen seconds with both units in operation. For life-saving and working purposes, there are two 27ft lifeboats and two 26ft 6in motor-boats which are carried at boat deck level by Welin MacLachlan overhead gravity davits. There are in addition four Dunlop inflatable life rafts. Navigational aids include Kelvin Hughes radar and echo sounder, Decca Navigator, Sperry gyro-compass, Redifon radio telephone, Marconi receiver of voice communication and a direction finder. It is of interest to note that, in accordance with Admiralty instructions, the ship is fitted with a degaussing installation, the degaussing room being located on the main deck.

Propelling Machinery

To meet special service requirements, the ship is powered by diesel-electric machinery, a system which has already proved successful in an earlier ship, the "Patricia." The English Electric Company, Ltd., manufactured the main propelling machinery, which was installed by the shipbuilders, and which operates on the controlled voltage principle, using a modified Ward-Leonard control system. All four generators and the two propulsion motors are arranged in series circuit and from one to four generators can provide power for propulsion, and be switched in or cut out while the ship is under way. In any service condition or combination of generators the engines cannot be overloaded since the system limits the maximum power demand to the designed service rating of the engines. A general arrangement of the main machinery is shown in our line drawing.

Propulsive power is developed by four enclosed self-ventilated generators: each is rated at 292kW at 230V d.c., as a separately excited machine, and is also arranged as a self-excited machine for auxiliary service with an output of 250kW at 220V. A 75kW, 250V d.c. constant voltage auxiliary generator is mounted on top of each main generator and chain-driven at 1100 r.p.m. from the main armature shaft. An English Electric C.S.R.KM diesel engine, having six cylinders of 10in bore by 12in stroke, drives each generator. The engine is fitted with a Napier TS 200/1 turbo-blower and Napier-Serck aftercoolers and has a designed continuous brake mean effective pressure of 151 lb per square inch at 750 r.p.m., but has been derated to 108 lb per square inch at 700 r.p.m. and 539 b.h.p. for continuous unrestricted operation. Each combined power unit is rubber mounted on a three-point support. Lubrication of the engines is on the semi-dry sump principle and a gear pattern pressure pump, driven from the crankshaft, delivers oil from an external sump tank through a Philips magnetic filter, a strainer and a Serck oil cooler to the main supply rail. For each engine there are primary and secondary exhaust silencers mounted in the funnel. There are two four-unit exciter sets, one of which is a stand-by, sited one to port and one to starboard at the forward end of the engine-room and under the main switchboard flat. Each set is driven at 1500 r.p.m. by a 36 h.p. motor. For maintenance purposes there is a lifting beam and 5 cwt Morris close lift pulley block, arranged over each generator set.

Fresh water cooling is used for the diesel engines and the jacket water is automatically

maintained at a predetermined temperature by a thermostatically controlled mixing valve in the common fresh water circuit with two Serck heat exchangers. By this arrangement, an idle engine is kept warm and ready for service. Two Drysdale upright combined fresh water/salt water pumps, rated at 75 tons per hour against a 30ft head, provide the cooling water service.

When running free at 228 r.p.m., and towing at 205 r.p.m., each single armature, 460V d.c., 1270A propulsion motor is rated at 725 s.h.p. Both are totally enclosed forced ventilated, eight-pole machines and the armature shafts are carried in Michell combined thrust and journal bearings at the aft end and by Michell journal bearings at the forward end. Because of limitation of space, the frames can be rotated so that any of the eight poles can be easily withdrawn. Cooling air is drawn from boat deck level by two axial flow Keith Blackman fans, mounted in the casings, which operate in parallel and deliver into a common trunk which supplies both motors. Each motor drives a four-bladed propeller having a diameter of 7ft 6·9in and a constant pitch of 7ft 3·6in, manufactured by J. Stone and Co. (Propellers) Ltd.

The propulsion motors are separately excited from their own exciters which have separately excited fields, energised from the constant voltage auxiliary supply, through potentiometers in the motor controllers. Control of the motors is either directly from the bridge telegraphs or from the engine-room in response to orders. There are six fixed-speed steps which give adequate propeller speed control for normal manœuvring, but when keeping station a finer adjustment is provided by a Vernier control fitted in the wheelhouse.

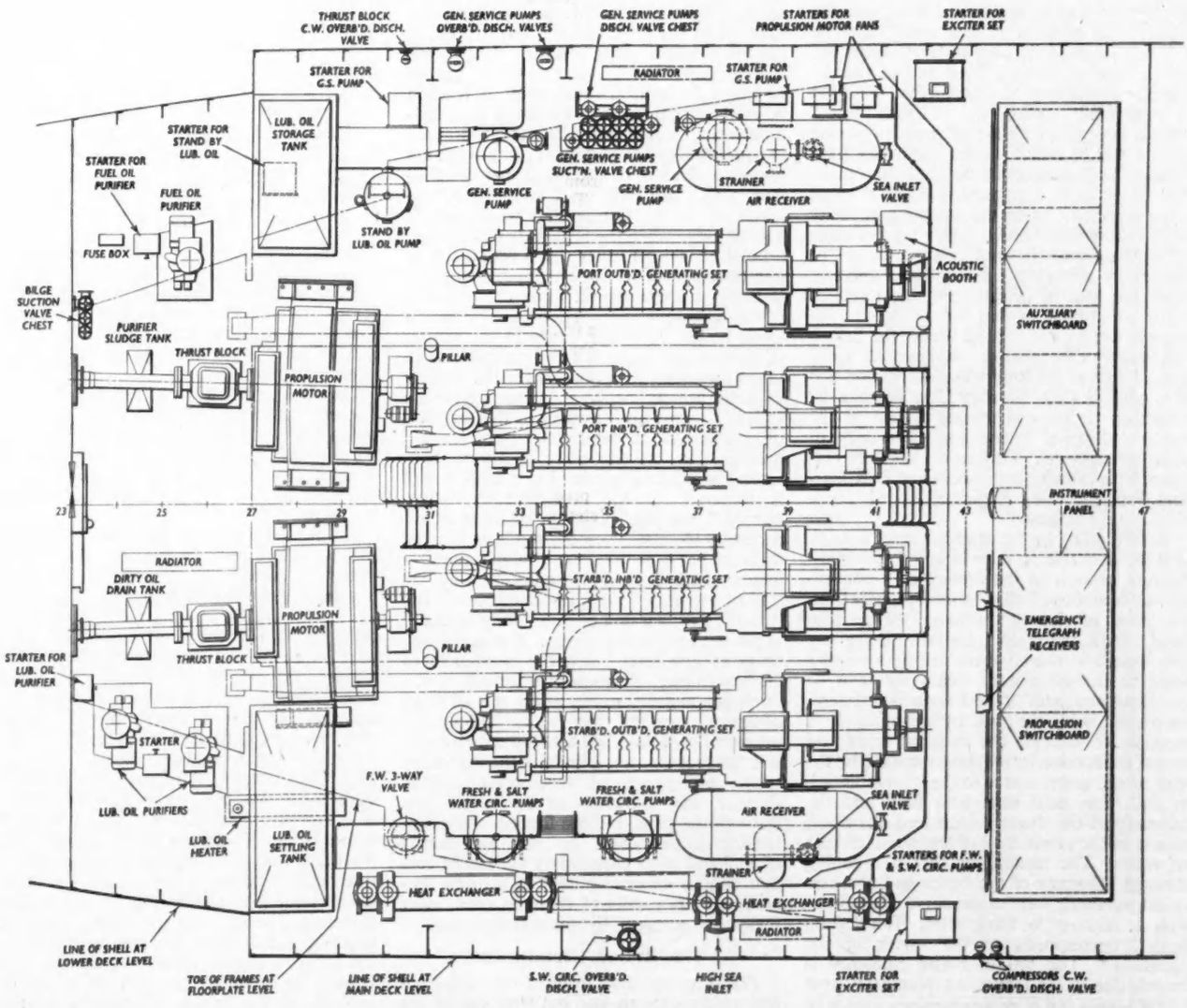
Both the main and auxiliary machinery switchboards are arranged on a flat at the forward end of the engine-room, with the watch-keeper's desk arranged on the centre-line between the two boards. Power for the deck machinery is supplied by one of the main generators and when on this duty the generator concerned is switched from the propulsion to the auxiliary busbars.

Auxiliary Machinery

For pumping purposes, Drysdale and Co., Ltd., has supplied two general service pumps rated at 34/50 tons per hour at 150/50ft head, one stand-by lubricating oil pump having a capacity of 70 gallons per minute at 90 lb per square inch plus 10ft suction lift. There are also fitted in the hold, for supplying lighthouses and lightships, two fuel oil transfer pumps capable of delivering 4000 gallons per hour at 100ft head plus 25ft suction lift and two 3000 gallons per hour at 80ft head fresh water transfer pumps, all the pumps being fitted with meters. All the above pumps are powered by Allen motors. For sanitary purposes there is a 6½ tons per hour Megator pump.

The Alfa-Laval Co., Ltd., has provided one 250 gallons per hour fuel oil purifier and two 200/240 gallons per hour lubricating oil purifiers. Starting air is supplied at 350 lb per square inch to two air receivers, each of 44 cubic feet capacity, by two Reavell compressors, one delivering 26 cubic feet of air per minute and driven at 950 r.p.m. by a 13 h.p. electric motor, and the other of 13 cubic feet of air per minute capacity and driven at 1000 r.p.m. by an 8 b.h.p. Petter diesel engine.

For heating and ventilating the machinery space and to prevent condensation, air is trunked to the generators and is discharged by integral fans at the commutator end through ducts below the floor plates. This arrangement cools the generators and draws carbon dust from the brushes away from the windings. When in harbour power is supplied by a 60kW generator and a 30kW generator, both of English Electric manufacture and driven by National oil engines of 110 b.h.p. and 62 b.h.p. respectively. To deal with 400/440V, three-phase a.c. shore supplies there is a 30kW motor generator.



Arrangement of machinery of lighthouse tender "Siren"

Locomotive Coal Trials

By E. C. POULTNEY, O.B.E.

No further steam locomotives are being built for British Railways. Nevertheless for many years to come "steamers" will still be in service. Those "steamers" may well have to "make-do" with less satisfactory coal than in the past. Trials have therefore been conducted at the Rugby Locomotive Testing Station to determine the possible effect of the size of the coal fired on the evaporative capacity of locomotive boilers at different rates of firing and on the evaporation attainable.

ONE of the advantages of the steam locomotive is the fact that it can use coals differing widely in quality with relatively little effect on its efficiency. However, wide as the tolerance of fuel quality may be it has its limits and these limits are in some instances now being reached and will, it is thought by British Railways, be reached more frequently before the steam locomotive ceases to be an important factor in the motive power of British Railways. It is of course realised that the steam locomotive can be designed to burn effectively very low grade coal. But it may not be easy to burn coal of a quality much lower than that for which a particular locomotive was originally designed. In British practice locomotive boilers have been designed and proportioned to produce the steam required when using coal of relatively large sizes and of a high calorific value. Further, so long as coal sizes did not vary too widely, coal of different heat values could be and was successfully used without alterations to the type of firebars fitted and to the designed draughting arrangements of what is commonly called the "Front End." Faced, however, with the prospect of having to use coal of much smaller sizes than have hitherto been considered desirable, the question arose as to how much the use of small sized coal may affect the steaming capacity of the locomotive boiler under normal rates of working and to what extent ultimate or maximum steaming rates will be affected. With the idea of investigating the result of using small coal as fuel for locomotives of normal design and "hand fired," the British Transport Commission inaugurated some special tests at the Rugby Testing Station and through E. S. Cox, Assistant Chief Mechanical Engineer, it has courteously placed at the writer's disposal interesting particulars of these experiments. This article has been prepared with valuable assistance from D. R. Carling, Superintending Engineer, Rugby Locotive Testing Station.

Before going on to describe these tests, it may be desirable to refer briefly to the combustion process in the firebox of a conventional locomotive boiler, more especially from the point of view of the nature of the coal fired. With any given locomotive using any given quality of coal there will be an upper limit to the amount of steam that can be produced and used. If the draught is sufficient, increasing with the rate of steaming, it is possible to increase the rates of firing and steam production to the limit imposed by the size of the grate, that is to the "grate limit." If still more coal were now fired and the intensity of the draught increased, the result would be the production of less steam instead of more. The reason for this is a falling thermal efficiency of the boiler and a consequent parabolic form of the curve of evaporation in relation to firing rates. The "grate limit" corresponds to the vertex of the parabola.* The fall in boiler efficiency is mainly due to the increasing quantity of coal carried out of the firebox in a more or less unburned state in the fast moving gas stream, and eventually this loss will become so large that it will have the effect mentioned. Actually there is always some loss of this kind, more especially at the higher rates of firing and the amount of such losses will depend to a large extent upon the quality of the coal used. In British practice, excessive losses of this description are, however, uncommon because in general the draught available is insufficient and it is the draught available which sets a limit on firing rates so that a "front end limit" is reached at a lower steaming rate than that corresponding to the "grate limit." Generally the limit set by the draughting arrangement, i.e. the "front end limit," occurs at some firing rate and at some particular rate of evaporation considerably lower than that which would be reached if the boiler could be fired up to the limit set by the grate and the vertex point in the evaporation curve reached. Unlike the "grate limit" the "front end limit" cannot be precisely defined. This point is reached when the steam exhausted through the blastpipe can no longer produce enough draught to produce a sufficient flow of air through the grate and firebox to sustain proper combustion, which can only be determined by observation by the testing staff who must be able to judge when the firing rate has reached a point at which further steam production is unattainable. This is an important point because on it can depend a proper evaluation of the maximum evaporation possible with a given boiler. In connection with the subject of combustion, there is a further point to be taken into consideration. This is the amount of unburned air or, as it is more generally called, "excess air" present in the products of combustion as determined from the gas analysis. In practice there is always considerably more air admitted to a firebox than is required for the coal actually "fully burned" and the minimum quantity of air necessary to sustain combustion is considered to be 25 per cent in excess of actual requirements which is stated to coincide with the "front end limit." In all cases the amount of "excess air" per unit of coal "fully burned" varies with the rate of firing. It is at a maximum at low rates when the resistances to air flow through the grate and firebed are at a minimum and diminishes as the rate of firing advances, meaning that the air supply per pound of coal fired is gradually reduced and it is this fact that sets a limit on the maximum steam production of locomotive boilers. Further, the resistance set up to air flow through the grate and the firebed is the controlling factor which governs the quality of coal and more particularly the size of coal that can be effectively used in a given firebox, and the results of the tests now under review are governed by this consideration.

* The parabolic form of the evaporation curve is due to the straight line relation between efficiencies and rates of firing uniformly falling as the rate at which the coal is fired increases.

The Rugby Experiments

The principal tests forming the subject of this article were carried out with one of the British Railways standard 4-6-0 locomotives class "5" of the same type and class as engine No. 73008 previously tested on the Rugby plant but modified with respect to the size of the blastpipe nozzle and the type of grate fitted as the result of certain supplementary tests also made at Rugby with the standard class "5" locomotive No. 73030 as used for these later tests. In addition to the class "5" tests, further investigations have been made using in this case one of the three-cylinder 4-6-0 type express passenger engines of the "Jubilee" class, No. 45722, L.M.S. Power Classification 5XP. The locomotives of this class were originally designed by Sir W. Stanier for the L.M.S. Railway in 1934 and since being fitted with modified boilers first adopted in 1936 have proved very successful engines.

"Jubilee" class locomotive No. 45722 has the later design of boiler and has been further modified as a result of experiments carried out at Rugby with an amended draughting arrangement to be mentioned again later. Some dimensions of the boilers as used for the B.R. standard class "5" and the "Jubilee" class engines are given in Table I.

TABLE I—*Locomotive Dimensions—B.R. Class "5" M.T. and L.M.S. "Jubilee" Class*

	B.R. class "5"	L.M.S. "Jubilee" class
Boiler working steam pressure lb per sq. in	225	225
Tubes No. and diameter outside, in	151—1¾	159—1¾
Flues No. and diameter outside, in	28—5¼	24—5¼
Length between tube plates, ft in	13 2⅛	13 2⅛
Superheater elements diameter outside, in	1⅛	1⅛
Free area through tubes and flues, sq. ft	4·5	4·33
Free air inlet through grate, sq. ft	10·74	12·6
Heating surfaces, sq. ft :		
Tubes and flues	1479	1460
Firebox	171	181
Total evaporative	1650	1641
Superheater	369	313
Combined	2019	1954
Grate area, sq. ft	28·7	31·0
Free gas area through tubes and flues, per cent of grate area	15·9	13·9
Free air inlet area through grate, per cent of grate area	37·45	40·6

This information relates to the heating surfaces, the dimension of the tubes and the flues containing the superheater elements, together with detailed particulars of the gas passage areas through the boilers and the free air inlet areas through the fire grates in both locomotives.

The Class "5" Tests—The Coal Used.—The coal used for the trials made with the class "5" locomotives was as follows: (1) Washed cubes, 6in to 3in; (2) Washed doubles, 2in to 1in; (3) Locomotive mixtures, 8in to 1in; (4) Locomotive mixtures, 6in to 1in.

All the above came from the Markham Main Colliery near Doncaster. When supplied as washed cubes, 6in to 3in this coal is graded 2B by British Railways. The 8in to 1in mixture had a nominal make-up of one-third 8in to 6in, one-third 6in to 3in, one-sixth 3in to 2in and one-sixth 2in to 1in. The dimensions, of course, relate to the mesh sizes of screens through which the coal will and will not pass. Actually the 8in to 6in part was prepared dry on a cracker, not washed, so that a good deal of small coal and fines was included. Also some of the pieces were much over size, up to 30in by 12in by 10in and these had to be broken up by hand before firing. There was also a tendency for the size of coal to be segregated in the wagon, this being a common occurrence, the small pieces settling at the bottom of the wagon in transit. The 6in to 1in mixture had a normal make-up of half 6in to 3in, one-quarter 3in to 2in and one-quarter 2in to 1in, but likely to contain more 2in to 1in than 3in to 2in on account of the greater production by this colliery of the 2in to 1in size than the 3in to

2in. As received there was about one-fifth large, a quarter 3in to 2in and half 2in to 1 in with some small and fines. The object of using the mixtures was to see how far mixing large and small coal together might mitigate the troubles found with small coal alone.

The Test Results

The results of the tests with the various qualities of coal can be conveniently shown by a tabulated summary as presented by Table II which gives for each trial the maximum rate of firing and the corresponding evaporations per hour and the rate of working as shown by the firing rates per square foot of grate area

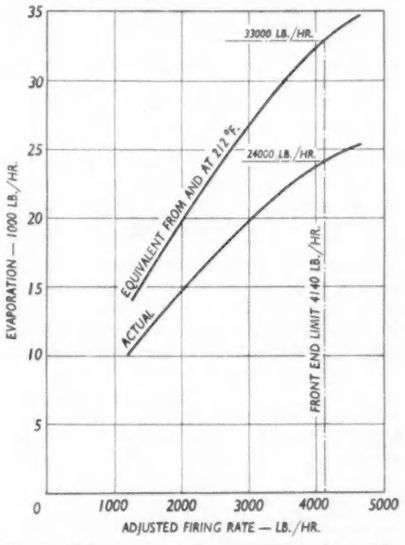


Fig. 1—Firing rates and evaporations, locomotive No. 73030, Blidworth coal

per hour. The firing rates are the " adjusted " rates, being those which would be necessary if the coal " as fired " had a calorific value of 12,600 B.Th.U. per pound. Other information included the thermal efficiency of the boiler at maximum rate of working and for convenience the figure numbers of the graphs showing evaporations in relation to the rates of firing for each of the tests. When considering the rates of firing during these tests it will first be necessary to go back to those originally carried out at Rugby with the class " 5 " Standard locomotive 73008, and in particular the results obtained when Blidworth grade 2B coal was used having a calorific value of 12,600 B.Th.U. per pound " as fired." The various graphs given in the Test Report Bulletin No. 6 were based on this fuel and when subsequently engine No. 73030 of the same class was placed on the Rugby plant for investigations concerning the draughting arrangement the results obtained from the final tests carried out with an improved and now standard draughting arrangement embracing a modified blastpipe nozzle diameter of $4\frac{7}{8}$in and a grate with larger air inlets were all related to a Blidworth coal having a calorific value of 12,600 B.Th.U. per pound " as fired." The actual firing rates were replaced by " adjusted " rates so that the performance of the modified locomotive could be strictly compared with the results obtained with engine No. 73008.

The boiler performance of No. 73030 is given in detail by Table III on which Fig. 1 is based. The information furnished relates to the rates of firing both " actual " and " adjusted," the corresponding evaporations both actual and equivalent, together with the thermal efficiencies. Referring to Table II, the first line shows the maximum performance attained with No. 73030 on the basis of the

Table II—*Summary of Test Results. B.R. Class " 5 " Locomotive No. 73030*

	1	2	3	4	5	6	7	8	9	10
Coal	Size as fired	Calorific value, B.Th.U. per lb as fired	Max. coal fired, lb per hour	Max. coal fired, lb per sq. ft grate area per hour	Max. actual evaporation water, lb per hour	Max. actual evaporation water, lb per lb of coal fired	Max. equiv. evaporation water, lb per hour	Max. equiv. evaporation water, lb per lb of coal fired	Boiler efficiency, per cent	Figure number and line No.
Blidworth. Test Report Bulletin No. 5	Small Cobbles	12,600	4,140	144·1	24,000	5·8	33,000	7·97	61·5	1
Markham Main	Washed Cubes 6 — 3	12,644	3,650	127·2	21,000	5·75	28,800	7·87	60·7	2
	Washed Doubles 2 — 1	12,585	2,730	95·1	17,500	6·41	23,920	8·76	67·5	3
	Mixture 8 — 1	12 472	2,860	99·65	18,100	6·33	24,740	8·65	66·0	4
	Mixture 6 — 1	12,597	3,010	104·9	18,700	6·21	25,620	8·51	65·5	5

" adjusted " rates of firing which reached 4140 lb of coal per hour giving actual and equivalent evaporation of 24,000 lb and 33,000 lb of water per hour representing 14·2 lb and 20 lb per square foot of evaporative heating surface per hour. It will be noted that compared with Blidworth the Markham Main Washed Cubes produced comparable results, the boiler efficiencies being little different. The smaller coal, line 3, is seen to have cut down the evaporative capacity of the boiler very considerably on account of the less amount of coal which could be fired before the limit set by the available draught was reached. Both the mixtures of larger and smaller sized coals produced, as was expected, some improvement in the evaporations attained but still well below those obtained with Blidworth Small Cobbles and the Markham Main Washed Cubes. Comparing the equivalent evaporations obtained with all four coals, which were 28,880 lb, 23,920 lb, 24,740 lb and 25,620 lb of water per hour, the evaporations per square foot of evaporative heating surface were 17·45 lb, 14·5 lb, 15·0 lb and 15·55 lb of water per hour, representing heat outputs materially less than were possible with Blidworth coal of normal quality as regards size " as fired." In the case of each of the qualities of coal lines 3, 4 and 5, Table II, the maximum quantities that could be fired and therefore the amount that could be " fully burned " were severely limited by an inadequate supply of primary air for combustion. It is, of course, true that supplementary air may be admitted through the firedoor, and in fact with hand-fired boilers appreciable quantities of air entered the firebox in this manner. While the air so furnished may assist in burning the volatile content of the coal it is nevertheless much more desirable for the combustion air to be admitted through the grate to burn the fixed carbon. " Top air," unless carefully controlled, can result in lower firebox and flue gas temperatures, which will tend to reduce the amount of superheat carried by the cylinder feed steam, while at the same time this air will also reduce the CO_2 content in the products of combustion by adding to the " excess air." In the case of the present tests when burning the Washed Cubes the " excess air " supply fell in round figures from 37 to 32, 28, 26 and 25 per cent for amounts of " dry coal " " fully burned " of 1000 lb, 1500 lb, 2000 lb and 2750 lb per hour respectively, but when burning the Doubles, line 3 Table II, the " excess air " percentages were 36, 29, 26 and 25 per cent when 1000 lb, 1500 lb, 2000 lb and 2750 lb of coal were " fully burned " per hour. These " excess air " percentages indicate clearly how small sized coal can retard the supply of air through the grate and firebed. Further though, at the lower rates of firing, air supplies per pound of coal " fully burned " were similar as shown by the percentages of " excess air " the rate of falling off was much more rapid, the minimum being reached when about 20 per cent less coal was " fully burned " and almost 25 per cent less fired. At moderate rates of working the resistance to air flow through the grate experienced with small coal can be counteracted to some extent by opening the ashpan dampers further, but as firing rates advance the dampers must be opened more and more until fully open and beyond this stage air shortage becomes more acute resulting in a rapid deterioration in combustion. In connection with the " adjusted " rates of firing for the four tests lines 2, 3, 4 and 5, Table II and the " actual " weights of coal fired were 3636 lb, 2733 lb, 2889 lb and 3011 lb per hour, the slight difference between these

Table III—*B.R. Standard Class " 5 " M.T. 4-6-0 Locomotive No. 73030. Firing Rates and Evaporations*

Coal : Blidworth Small Cobbles—Representative C.V. 12,600 B.Th.U.

Actual firing rate, lb per hour	Calorific value for tests, B.Th.U. per lb	Adjusted firing rate, lb per hour	Actual evaporation rate, lb per hour	Equivalent evaporation, lb per hour	Boiler efficiency, per cent
1420	12,552	1415	10,860	14,430	78·55
1480	12,768	1500	11,500	15,390	79·10
1520	12,620	1527	11,540	15,490	78·10
2060	12,656	2069	14,940	20,080	74·75
2090	12,483	2071	14,750	19,880	73·95
2070	12,768	2098	15,330	20,720	76·10
2112	12,620	2115	15,120	20,500	74·70
2130	12,581	2127	15,230	20,450	74·10
2070	13,002	2136	15,330	20,670	74·50
2120	12,707	2138	15,250	20,490	73·80
2120	13,002	2188	15,450	20,790	73·15
2280	12,620	2284	15,730	21,400	72·25
2330	12,768	2361	16,200	22,000	71·75
2460	12,533	2447	17,490	23,720	74·75
2490	12,768	2523	17,740	24,070	73·50
2550	12,656	7561	17,620	24,020	72·30
2590	12,552	2580	17,440	23,770	70·95
2580	12,656	2591	17,970	24,470	72·75
2680	12,768	2716	18,210	24,800	70·40
3350	12,656	3365	21,040	29,150	66·75
3450	12,483	3418	21,140	29,010	65·45
3590	12,620	3606	21,800	30,270	64·65
3533	12,865	3607	21,670	29,760	63·65
3660	12,483	3626	21,930	30,100	64·70
3820	12,533	3800	23,600	32,400	65·75
3872	12,865	3872	23,230	32,140	63·95
4010	12,533	3989	23,820	32,820	63·45

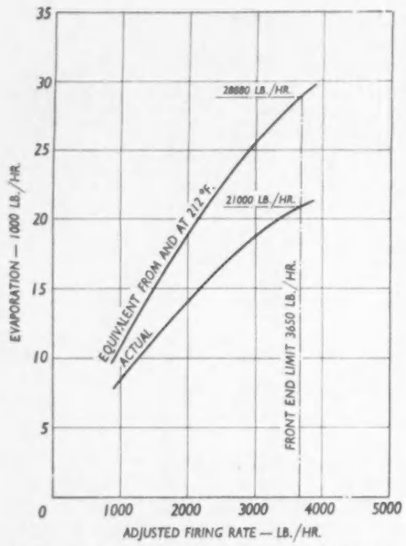


Fig. 2—Firing rates and evaporations, Markham Main. Washed cubes

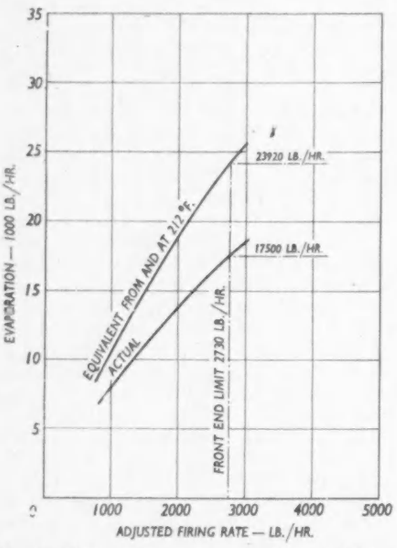


Fig. 3—Firing rates and evaporations, Markham Main. Washed doubles

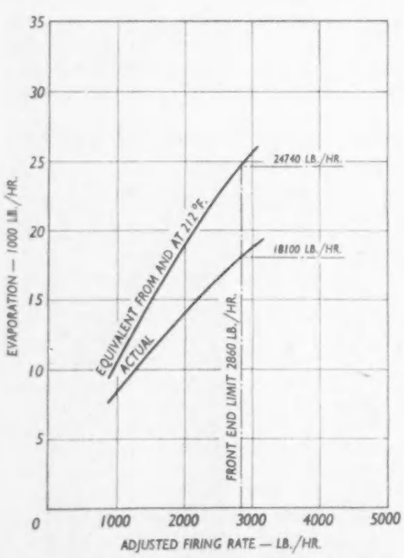


Fig. 4—Firing rates and evaporations, Markham Main. Mixture 8×1

and " adjusted " amounts being of course due to the small difference between the calorific values of the coal " actually " fired and the representative value of 12,600 B.Th.U. per pound for the Blidworth coal.

Boiler Efficiencies

The thermal efficiency of the boiler is shown by Fig. 6 which, though actually plotted for the trials made with the Markham Main Washed Cubes, is in point of fact representative of all the four tests. In each case the average line as shown fairly represents all the tests so far as the evaporative efficiency of the boiler is concerned. Taking into consideration that the efficiency of the boiler is as already stated based on " adjusted " rates of firing meaning in other words on equal rates of firing B.Th.U. per hour and also at equal rates per square foot of grate area it is therefore likely that the efficiencies would be equal. Further, the efficiencies shown by the representative plot, Fig. 6, are reflected by the equivalent evaporations shown by Figs. 2, 3, 4 and 5 where the only differences are seen to be the maximum rates of firing possible with the different qualities of the coal. In connection with the latter point and referring to the boiler efficiencies given by Table II, it is of interest to observe that the efficiencies applying to the tests lines 3, 4 and 5 are higher than those for tests lines 1 and 2, even though in each case the efficiency is that shown at the maximum rate of firing as determined by the " front end limit " for each quality of coal. This is a somewhat interesting point as it might reasonably be thought that the " front end limit " had not been quite reached. However, it is understood that such was in fact the case. The boiler efficiencies given are those shown by the average lines and are not therefore exactly as would be obtained from the water/coal ratios for the equivalent evaporations. It may also be here stated that when making each of the several tests, boiler efficiencies are first computed for each rate of firing and an average line located from which the equation relating efficiencies and rates of firing is obtained. Equivalent evaporations are then estimated from the mean boiler efficiencies. They are not plotted direct from the corresponding water/coal ratios derived from each specific test. On the other hand it is expected that points denoting specific rates of evaporation would be expected to group themselves closely about evaporation curves derived from the mean efficiency characteristic.

The " Jubilee " Class Locomotive Tests

The coal trials conducted at Rugby with the three-cylinder engine of the " Jubilee " class No. 45722, which like the class " 5 " engine No. 73030 had had its draughting arrangements modified, were made with two different grades of coal, one a grade 2B Blidworth with an " as fired " calorific value of 12,400 B.Th.U. per pound, and another lower grade 3B coal Bestwood with an " as fired " calorific value of 11,272 B.Th.U. per pound. The approximate analysis of these two coals taken from representative samples are as given below:—

A good deal of the Bestwood grade 3B coal was supplied in large sized pieces so that it had to be broken up before it could be used. This had the effect of adding to fines

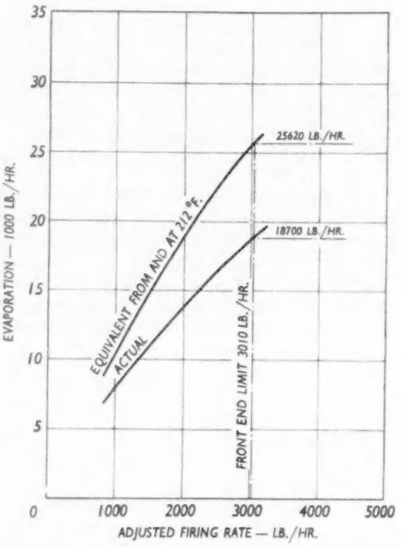


Fig. 5—Firing rates and evaporations, Markham Main. Mixture 6×1

and to a certain amount of small coal already present. The performance of the boiler with both kinds of coal will be considered later after the improved draughting arrangements already mentioned have been described.

As Received Values

	Blidworth	Bestwood
Moisture, per cent	7·37	13·16
Volatile matter, per cent	33·35	32·37
Fixed carbon, per cent	52·64	48·06
Ash, per cent	6·64	6·41

Dry Coal

Volatile matter, per cent	36·0	37·08
Fixed carbon, per cent	56·83	55·34
Ash, per cent	7·17	7·28

Modified Blast Pipes

To improve the steaming capacity of the boiler which would be likely to enable locomotives of this class to handle traffic when using lower grade coals as required when better fuel is not available, interesting investigations were made at Rugby with different blast pipes and chimney arrangements. As normally used " Jubilee " class engines have been fitted with a conventional single blast pipe and chimney the exhaust nozzle of the tapered description having a diameter of $4\frac{3}{4}$in. Two modified arrangements were fitted by way of experiment, one consisting of a single blast pipe and chimney, the nozzle in this case being virtually cylindrical with a sharp edged orifice at the top and a diameter of $5\frac{1}{2}$in. The second modification used a double blast pipe with two $4\frac{1}{8}$in diameter nozzles in design like the $5\frac{1}{2}$in single nozzle and a double chimney. The majority of the experiments were made when the $4\frac{1}{8}$in nozzles were fitted. These two modifications were designed to give a near as possible equal evaporations, though actually the duplex blast pipe arrangement did in fact draw just a

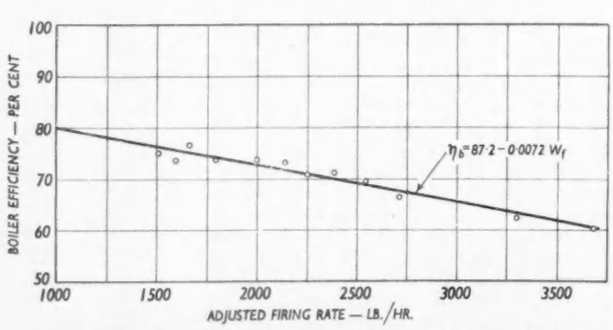


Fig. 6—Boiler efficiency. Markham Main coal. Washed cubes

little more air than the single chimney modification at the highest rates of working. Eventually 4⅜in nozzles were recommended as being satisfactory, which resulted in reducing slightly the exhaust steam pressure, as indicated by Fig. 7, "Comparative Draught Relationships." This graph is so complete that little comment is called for, but attention can be directed to the performance of the duplex chimney arrangement which is shown to be very effective in producing the draught required with low exhaust steam pressures. The modified single and double chimney designs were equally effective in producing and exhausting more steam than was possible with the original single chimney arrangement when the coal fired was of the same grade 2B Blidworth. The steam produced and exhausted at the highest rates of evaporation in relation to exhaust steam pressures was as follows:—

Original Single Chimney

Evaporation water, lb per hour	20,760
Exhaust steam pressure, lb per sq. in	6·8

New Single and Double Chimneys

Single chimney

Evaporation water, lb per hour	25,000
Exhaust steam pressure, lb per sq. in	8·1

Double chimney

Evaporation water, lb per hour	25,000
Exhaust steam pressure, lb per sq. in	5·7

For an evaporation of 20,760 lb of water per hour the new single-chimney arrangement required an exhaust steam pressure of 5·6 lb and the double chimney 3·8 lb per square inch. The above figures have been estimated by sight from the graph Fig. 7 and for this reason must be considered as being close approximations.

Evaporative Performance

The evaporative performance of the boiler with the original and modified chimney arrangements and when using grade 2B Blidworth coal and for grade 3B Bestwood coal is given by Figs. 8 and 9, "Boiler Relationships," based on Fig. 8 the evaporative performance is shown to be as under:

Blidworth Coal

Evaporation water, lb per hour	20,760
Evaporation water, lb per hour per square foot of evap. heating surface	12·66
Coal fired per hour, lb	3,324
Coal fired per hour, lb per square foot of grate area	107·2
Water/coal ratio	6·24

New Chimney Arrangements

Evaporation water, lb per hour	25,000
Evaporation water, lb per hour per square foot of evap. heating surface	15·2
Coal fired per hour, lb	4,435
Coal fired per hour, lb per square foot of grate area	143·1
Water/coal ratio	5·64

Bestwood Coal, Fig. 9. Double-Chimney Arrangement

Evaporation water, lb per hour	21,750
Evaporation water, lb per hour per square foot of evap. heating surface	13·26
Coal fired per hour, lb	4,219
Coal fired per hour, lb per square foot of grate area	136·2
Water/coal ratio	5·16

When comparing Figs. 8 and 9, "Boiler Relationships," an interesting point brought to notice is the fact that with the double-chimney arrangement the low grade Bestwood coal produced a maximum evaporation when the "front end limit" was reached rather higher than that obtained with the original single chimney when the higher grade Blidworth coal was used. Here it may be pointed out that the firing rates on which the different graphs are based for both the Blidworth and Bestwood coals are "adjusted" rates. They represent the weights of coal required if the coal fired had representative calorific values of 12,400 B.Th.U. per pound in the case of Blidworth coal and 11,272 B.Th.U. per pound for the Bestwood coal. The representative or standard heating values are derived from samples taken from the different deliveries of the coal. The previous

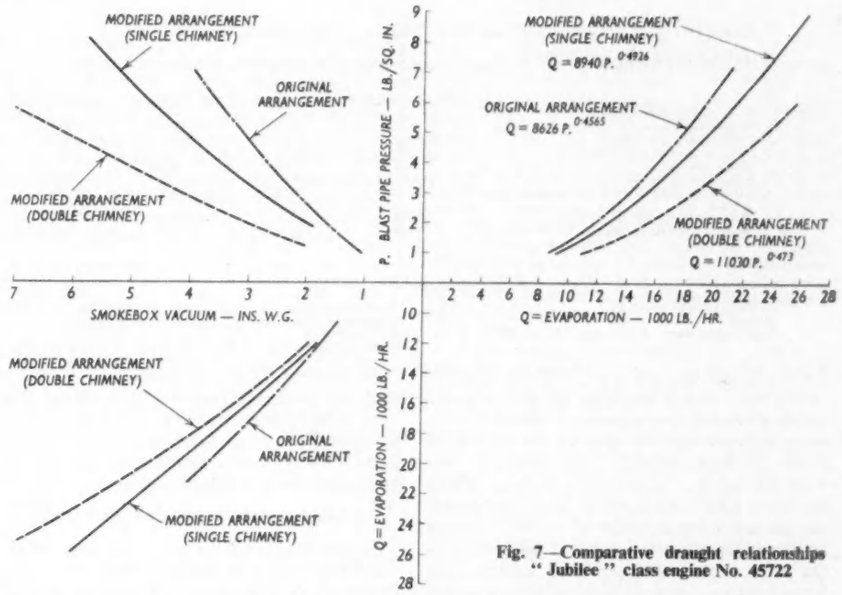
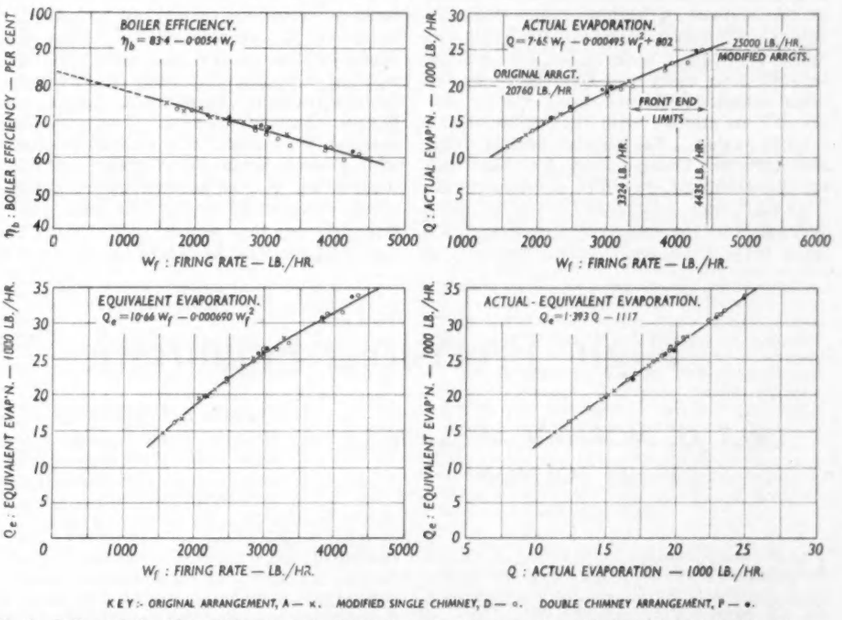

MODIFIED ARRANGEMENT (SINGLE CHIMNEY)
ORIGINAL ARRANGEMENT
MODIFIED ARRANGEMENT (DOUBLE CHIMNEY)
P. BLAST PIPE PRESSURE — LB./SQ. IN.
SMOKEBOX VACUUM — INS. W.G.
MODIFIED ARRANGEMENT (SINGLE CHIMNEY) Q = 8940 P.^0·4926
ORIGINAL ARRANGEMENT Q = 8626 P.^0·4565
MODIFIED ARRANGEMENT (DOUBLE CHIMNEY) Q = 11030 P.^0·473
Q = EVAPORATION — 1000 LB./HR.
MODIFIED ARRANGEMENT (DOUBLE CHIMNEY)
ORIGINAL ARRANGEMENT
MODIFIED ARRANGEMENT (SINGLE CHIMNEY)
Q = EVAPORATION — 1000 LB./HR.

Fig. 7—Comparative draught relationships "Jubilee" class engine No. 45722


BOILER EFFICIENCY. ηb = 83·4 — 0·0054 Wf
ηb : BOILER EFFICIENCY — PER CENT
Wf : FIRING RATE — LB./HR.
ACTUAL EVAPORATION. Q = 7·65 Wf — 0·000495 Wf² + 802
25000 LB./HR. MODIFIED ARRGTS.
ORIGINAL ARRGT. 20760 LB./HR
FRONT END LIMITS
3324 LB./HR.
4435 LB./HR.
Q : ACTUAL EVAP'N. — 1000 LB./HR.
EQUIVALENT EVAPORATION. Qe = 10·66 Wf — 0·000690 Wf²
Qe : EQUIVALENT EVAP'N. — 1000 LB./HR.
ACTUAL - EQUIVALENT EVAPORATION. Qe = 1·393 Q — 1117
Q : ACTUAL EVAPORATION — 1000 LB./HR.

KEY:- ORIGINAL ARRANGEMENT, A — ×. MODIFIED SINGLE CHIMNEY, D — ○. DOUBLE CHIMNEY ARRANGEMENT, P — ●.

Fig. 8—Boiler relationships. Blidworth coal. Original single chimney and modified single and double chimney

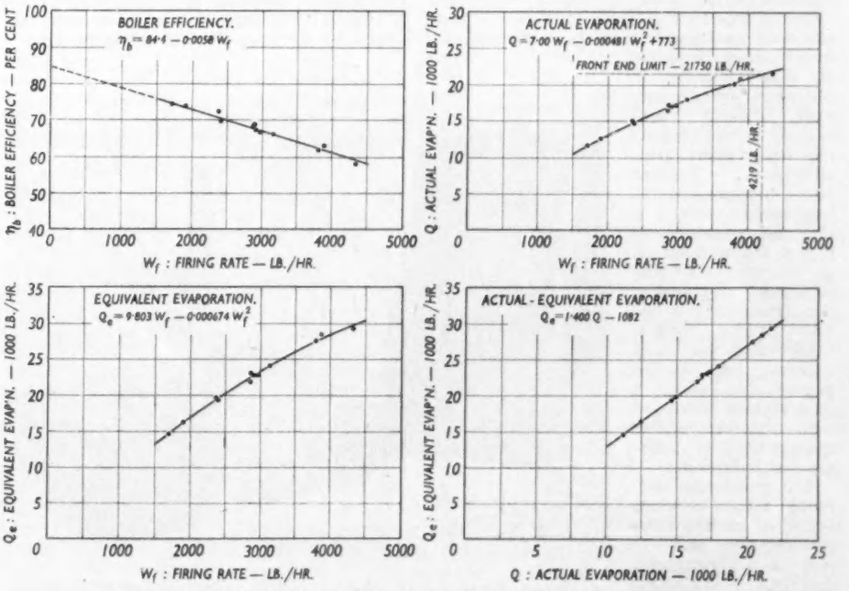

BOILER EFFICIENCY. ηb = 84·6 — 0·0058 Wf
ηb : BOILER EFFICIENCY — PER CENT
Wf : FIRING RATE — LB./HR.
ACTUAL EVAPORATION. Q = 7·00 Wf — 0·000481 Wf² + 773
FRONT END LIMIT — 21750 LB./HR.
4219 LB./HR.
Q : ACTUAL EVAP'N. — 1000 LB./HR.
EQUIVALENT EVAPORATION. Qe = 9·803 Wf — 0·000674 Wf²
Qe : EQUIVALENT EVAP'N. — 1000 LB./HR.
ACTUAL - EQUIVALENT EVAPORATION. Qe = 1·400 Q — 1082
Q : ACTUAL EVAPORATION — 1000 LB./HR.

Fig. 9—Boiler relationships. Bestwood coal. Double chimney arrangement

TABLE IV—*L.M.S. Locomotive Tests* 1937. "*Jubilee*" *Class Engine No.* 5660 "*Rooke*"

Locomotive weight 1 tender loading, 121·6 tons. Train eight 8-wheel coaches and dynamometer car 302 tons. Total weight 423·6 tons.

		Glasgow–Leeds	Leeds–Bristol	Bristol–Leeds	Leeds–Glasgow
1	Average speed, m.p.h.	56·8	55·3	55·4	56·3
2	Coal fired, lb per mile	43·6	51·1	53·7	42·7
3	Water from tender, lb per mile	288·0	350·0	337·0	297·0
4	Water/coal ratio	6·61	6·85	6·28	6·96
5	Coal fired, lb per hour	2476·4	2825·8	2974·9	2404·0
6	Coal fired, lb per sq. ft of grate area per hour	79·9	91·2	96·0	77·4
7	Water from tender, lb per hour	16,358	19,355	18,669·8	16,721·1
8	Water evaporated per sq. ft of evap. h.s. per hour	9·98	11·8	11·38	10·18

Boiler Heating Surfaces, Square Feet

Tubes (large and small)	1460 sq. ft	Superheater	307·0 sq. ft
Firebox	181·1 sq. ft	Combined	1948·1 sq. ft
Total evaporative	1641·1 sq. ft	Fire grate area	31·0 sq. ft

Tables II and III indicated how the calorific values may vary as between one delivery and another for any given grade of coal from the same colliery. In the case of the Bestwood grade 3B coal, actually four different lots were sampled, the calorific values falling between 11,137 and 11,486 B.Th.U. per pound and having a mean value of 11,287. Taking into consideration the number of tests with the coal represented by each sample, the average came out at 11,275 and as one actual sample showed, a heating value of 11,272 B.Th.U. per pound "as fired," this value was taken as being representative and all the separate tests using coal represented by the other samples had their firing rates "Adjusted" to comply with the representative calorific value. As will be evident from the calorific values given for the coal samples examined, the difference between the "Actual" and "Adjusted" rates of firing were, as was the case with the class "5" tests, very small and in fact the largest "Adjustment" only amounted to 81 lb of coal per hour increase over the actual rate. This would mean an increase in the rate of firing of 2·61 lb of coal per square foot of grate area per hour, which might reasonably be considered a negligible amount.

A Comparison With Previous Tests

In connection with the performance of the "Jubilee" class locomotive when fired with Blidworth coal it may be of interest to recall some previous tests carried out with another engine of the same class in 1937. These were made with locomotive No. 5660 "Rooke" working a special test train to accelerated timings between Glasgow (St. Enoch) and Bristol (Temple Meads). Two complete journeys were made, one in each direction, with a train made up of eight 8-wheeled coaches and a dynamometer car at average speeds of about 55 m.p.h. The trailing load was 302 tons tare weight. The locomotive was in all respects like No. 45722, except that the original single chimney draughting arrangement was fitted and 1¾in diameter superheater elements the standard at that time with the new enlarged boilers as for No. 45722. For special trials of this kind the former L.M.S. Railway made a practice of using a high grade Yorkshire coal (Grimethorp) with a heating value of 14,500 B.Th.U. per pound and as this was used for these "Jubilee" class tests the boiler performance cannot really be compared with the Rugby plant tests under review. Nevertheless, the extraordinary performance put up by engine No. 5660 is worth recalling and for this reason Table IV has been prepared which sets out the average results so far as the boiler is concerned.

These trials were considered to represent a performance about the maximum for locomotives of this class. The highest actual rate of evaporation reached is understood to have been about 27,000 lb of water per hour and the highest firing rate approximately 150 lb of coal per square foot of grate area per hour. It will be observed that mean firing rates range between a maximum of 2974 lb to 2404 lb of coal per hour, which may be compared with 3000 lb of coal per hour officially considered to represent the maximum for continuous firing for one fireman. Maximum rates rather higher were attained at Rugby during the tests with engine No. 45722 with the original draughting arrangement, while with the improved single and double chimneys the mean rate recorded was considerably higher at 4435 lb per hour, which is rather below the hourly rate represented by a firing rate of 150 lb per square foot of grate area per hour which would be 4650 lb per hour.

High Precision Pneumatic Test Indicator*

By I. G. MORGAN, M.A., and F. R. TOLMON

The indicator employs the pneumatic technique, is sensitive to displacements of a few microinches and exerts only a light contact load. It is designed for surface-plate work of the highest precision. An important feature is that the display unit is remote from the measuring head and attached to it by a flexible connection. This offers great advantage in measurements at inaccessible points.

DIAL test indicators as described in British Standard 2795 : 1957, are commonly used in conjunction with slip-gauges and a surface plate for the dimensional inspection of gauges and workpieces. In some applications, involving measurement at rather inaccessible points, an operator may have difficulty in placing a conventional mechanical indicator so that he can readily read its scale. In such instances an instrument with a remote scale, flexibly connected to the measuring head, offers great advantage. Further, when measuring at an inaccessible point, it may be necessary to mount the indicator on an extended arm considerably overhanging the datum support and thus lacking rigidity. Under such conditions accuracy may be improved by using a contact load much less than the few ounces characteristic of ordinary dial indicators.

The pneumatic technique offers a ready means of meeting these requirements and to this end the instrument described in this article has been constructed. Bearing in mind increasing demands for the highest precision in engineering measurement the indicator is of high sensitivity. It is responsive, at an overall magnification of 12,500, to displacements of a few microinches. Its range is consequently restricted (0·0004in (0·01mm)) as compared with mechanical indicators, but the long range of the latter is not a real advantage when the highest precision is required as under these circumstances only a limited part of the range should be used.

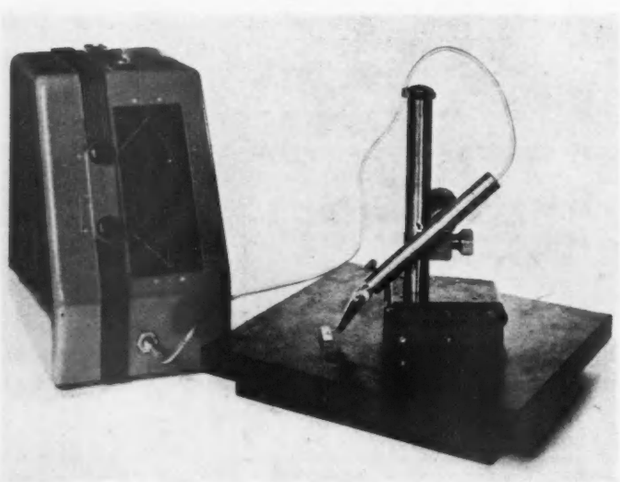


Fig. 1—Remote display unit and measuring head of pneumatic test indicator

The instrument is seen in Fig. 1 mounted on a suitable stand and connected to a Sigma "Dialair" scale and pointer-display unit. Of the various components required in the pneumatic measuring system the pressure regulator, control orifice and pressure-responsive element are all contained within the display unit. The pneumatic measuring technique is well known and has been adequately described elsewhere.[1] Detailed description will here be restricted to the measuring head itself.

Construction and Mode of Operation

The main features of the indicator are shown in Fig. 2. The ball-ended stylus *A* is mounted on a spindle pivoting in jewel bearings at *B*. Following conventional practice for mechanical test indicators the stylus is not rigidly fixed to the spindle but is held by a friction device. It may thus be turned on the spindle and set in any convenient position over a range of angular movement of about 90 deg. The force required to turn the stylus against the friction grip is 1·5 ozf (43 gf)† at the ball so that there is no risk of its being disturbed by the actual working force of 0·4 ozf (10 gf). Rigidly fixed to the spindle and projecting into the body *C* of the instrument is an arm *D* having at its free end a flat surface against which air from the jet *E* impinges. A spring (not shown), acting on this arm, provides the working force, moving the

* Communication from the National Physical Laboratory.

† 1 ozf = 1 ounce force : 1 gf = 1 gramme force.

arm towards the jet when there is no constraint on the stylus. Displacement of the stylus, causing the arm to move towards or away from the jet, changes the flow of air and gives rise to changes of pressure in the pneumatic circuit. The display unit responds to these pressure changes and is calibrated to read the displacement of the stylus directly in units of 0·00001in (0·25μm).

The body *C* is connected to the supporting arm *F* through a knuckle joint at *G*. The joint

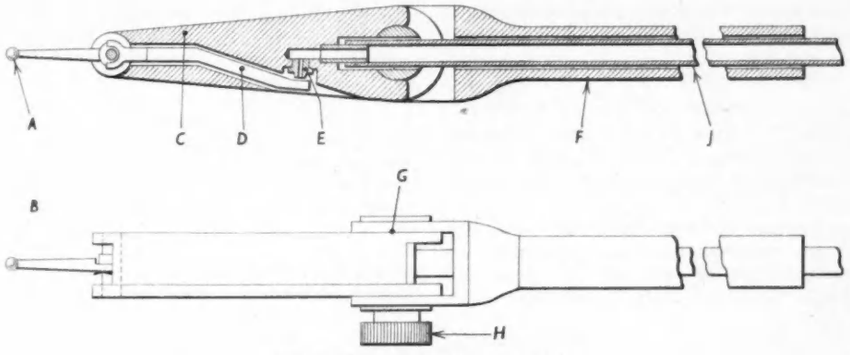


Fig. 2—Details of indicator construction

allows the body to be turned with respect to the supporting arm over a range of angular movement of about 90 deg. and clamped in a desired position by tightening the knurled knob *H*. This facility, together with that of turning the stylus on its spindle, greatly assists setting the indicator in a convenient working position.

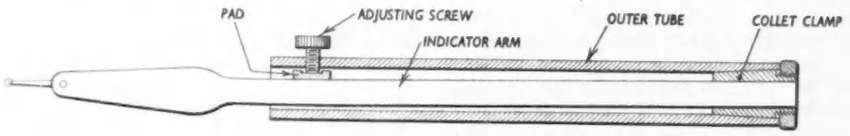


Fig. 3—Mounting of indicator within an outer tube

The supply of compressed air to the jet is fed through a flexible plastic tube *J* passing through the supporting arm and the knuckle joint. This arrangement, though slightly complicating the construction and assembly of the instrument, serves the essential purpose of eliminating any tendency for the drag of the tube to disturb the setting of the instrument when in use.

In Fig. 1 the indicator is seen mounted with the arm *F* enclosed within an outer tube of larger diameter. This arrangement, shown in Fig. 3, provides for convenient coarse adjustment of the indicator when it is used in conjunction with a stand which permits, as does the one illustrated, fine adjustment only. One end of the indicator arm is fixed in the outer tube by a collet-type clamp. At the other end a screw bears against the arm through an intermediate pad and adjustment over a range of about 0·03in (0·75mm) is obtained by bending of the arm when the screw is turned. The thickness of the intermediate pad is slightly greater than the free clearance between the indicator arm and the outer tube so that the comparatively thin arm remains stressed, and thus sufficiently rigid, however far the adjusting screw is retracted. This prevents accidental use of the assembly in a non-rigid condition.

The indicator stand illustrated is of a new design which has been described in detail by Pearce and Tolmon.[2] It possesses the high degree of rigidity essential to the use of a very sensitive indicator and provides for fine adjustment to a few microinches when used over a range of about 0·001in (0·025mm).

Performance

The reproducibility of the indicator reading was investigated by repeatedly introducing a slip-gauge between the stylus and a fixed datum surface without moving the indicator itself. The reading could be continually reproduced to within 8μin (0·2μm) and a set of thirty readings showed a standard deviation of 2·5μin (0·06μm).

This reproducibility of reading is most useful in applications where it is required to detect displacements relative to some datum with respect to which the indicator remains fixed. It cannot in general, however, be fully exploited in surface-plate work where the indicator stand is moved over the plate because errors of flatness of the latter introduce additional uncertainties of greater magnitude. A test using a restricted area of a surface-plate of the highest quality showed that the indicator was capable of comparing the sizes of two slip-gauge combinations differing by 0·0002in (5μm) to an accuracy within ±0·00001in (±0·25μm). Such precision could not be expected in routine work but the test establishes that the accuracy of the indicator itself will meet the most stringent requirements of all such work in which its remote reading facility is useful.

Acknowledgments

The authors wish to acknowledge the assistance of Mr. J. R. Boxall of the Standards Division Workshop, who in constructing the indicator also contributed to its detailed design. The work described above has been carried out as part of the research programme of the National Physical Laboratory and this paper is published by permission of the Director of the Laboratory.

References

[1] Evans, J. C., *J. Instn. Prod. Engrs.* (1957), 36, 110.
[2] Pearce, D. C., Tolmon, F.R., The Engineer, 1959, 208, 517; *Machinery*, 1959, 95, 1002; *Mach. Shop Mag.*, 1959, 20, 629.

Conference on Electronic Components and Materials, 1961

The Electronics and Communications Section of the Institution of Electrical Engineers announces that, with the support of the Council, it is organising a Conference on Components and Materials used in Electronic Engineering, to be held at the New Central Hall Westminster, S.W.1, from June 12 to 17 next year. The scope of the conference falls under the three main headings of materials, components and assembly techniques. It is intended to put special emphasis on new techniques of measurement, reliability and the effects of extreme operating conditions. The conference will not cover thermionic devices, transistors and other semiconductor devices, neither will applications be included, except when a reference thereto is essential to a description of the nature of components or materials. The institution invites the submission of papers for consideration. Further information can be obtained from the Secretary, the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Technical Reports

An Analysis of Steady Straight Flight with Inclined Thrust. By S. B. Gates and A. W. Thorpe. Reports and Memoranda No. 3096. H.M. Stationery Office. Price 11s. 6d.—Griffith's proposal to achieve vertical take-off and landing at the usual attitude demands sea-level thrust considerably greater than the weight and continuously rotatable through 90 deg. A study of the steady states of such a system is necessary as a preliminary to work on the flying techniques involved in the project. In this survey a vectorial method of analysis has proved useful in displaying the special features of the performance of such aircraft at both high and low speed.

The main conclusions are :

(*a*) The high-speed performance is sensibly a maximum when the thrust is along the axis of minimum drag. Hence, inclining the thrust is useless except in the grounding operations.

(*b*) When the thrust exceeds the weight by a substantial margin, steady flight is confined to very high speed in a very small incidence range. In this régime there are two flight-path angles for every incidence.

(*c*) Handling may therefore be difficult until, with increase of height, the thrust has fallen below the weight. If this proves to be so, it is suggested that the full thrust should be used to climb out of the " excess thrust " region as quickly as possible. The aerodynamic dividends in increased height and speed of economic cruise are obvious, but no attempt is made at a project assessment.

(*d*) At very low speed, the attitude corresponding to any given inclination of the thrust is almost constant, and a large range of low speeds and flight-path angles is possible.

A Study of the Granulators in the Production of Road Aggregates. Road Research Technical Paper No. 44. D.S.I.R. H.M. Stationery Office. Price 5s. 6d.—It is the performance of the granulator or final-stage crusher that determines the grading and shape of the final products from a plant preparing road aggregates. This report summarises the results of an extensive study of ten granulators covering the four main types, jaw, cone, impact and rolls, when used on twelve different types of rock.

Each machine was studied over the whole practicable range of operating conditions, the object of the work being to compile a large mass of information for the guidance of both manufacturers and users of granulators. The report should help producers of road aggregates to use their granulators to the best advantage in meeting the fluctuating demands for the different sizes of aggregate, and at the same time supplying each size asked for within the specification limits. The work was carried out in co-operation with the County Surveyor of Somerset in the County's quarry at Wells.

Modernisation of Forges. British Iron and Steel Research Association, 11, Park Lane, London, W.1. Price (to non-members) 10s.—In September, 1958, the British Iron and Steel Research Association held a conference on the modernisation of forges. Three papers were discussed, namely, " Building a New Forge, " by Mr. A. C. Lowe ; " Features that Make for a Well-designed Modern Forge, " by Mr. E. H. Kendall, and " A Method for Comparing Alternative Ways of Forging, " by Messrs. J. Banbury, J. V. Chelsom and D. H. Smellie. The full text of the papers and the discussion on them have been brought together, with the appropriate illustrations, to form this report.

Surface Water Year Book of Great Britain, 1957-58. H.M. Stationery Office. Price 15s.—A further increase in the number of permanent flow measurement stations is reported in the latest number of the *Surface Water Year Book of Great Britain.* This 1957-58 edition includes the records of 174 reporting stations compared with 147 in the previous volume. The Year Book is the only publication of its kind giving details of run-off and related rainfall in the principal river basins and reservoired areas. The period 1881-1915 has been retained for areal rainfall averages, but a new standard period 1916-50, for which the Meteorological Office is at present surveying the whole of Great Britain, will eventually be adopted.

Flame-Retardant Building Materials. H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 1s.—This publication outlines the methods in use for evaluating the flame retardant properties of combustible building material, and gives details of proprietary products that tests have shown to give the least assistance to fire spread.

LETTERS AND LITERATURE

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A great variety of past, present, and future designs are available for discussion in the section on jet rotors. The author makes clear in his introduction that in his philosophy of engineering, the condition for the survival of any technique is that it shall attain some accepted goal, and his intention is to show that jet rotors promise such a performance. Unfortunately, it is not made easy to follow his thinking, at least in part because of the casual manner of introducing concepts which pages later become vital ; a definition of coning angle, β, subtle beyond the verge of obscurity is used, and hence we later find

$$F_r(\beta) = F_r(0) \cos^3 \beta$$

where F_r is the force exerted by the air on the rotor, which is unwelcome since one expects to fly at coning angles less than that for maximum lift. Reasonably and rightly, great emphasis is given to the severe limitation imposed by the existence of this maximum coning angle and apparent to the pilot as a minimum rotor speed restriction, since it is this limitation that leads to blade tip ballast. The rotor radius at which a jet engine to power the rotor would have the same weight as the required ballast is stated to be the optimum size for a jet rotor, since it is the only size at which the rotor weight is not greater than that of a shaft-driven rotor ; before accepting this, one would wish for assurance that the weight of the ballasted rotor was stationary at this radius. These difficulties, however, do not prevent this section presenting an excellent exposition of the limitations of rotor craft ; it is submitted that the asymmetric rotor, i.e. one providing lift in near-horizontal flight, is perforce low-subsonic because of the severe variation in flow direction that would be experienced by an intake at the tip—a diffuser that would tolerate 4 deg. misalignment at 2000ft per second would limit flight to 95 m.p.h. Despite this obvious prompting, little or no consideration is given to the system in which air is ducted along the blades and burnt at the tips ; considering that the transfer of the engine weight from the tips, where it is useful, to the hull reduces the optimum size intolerably, the author does not even point out that the energy absorbed by the air flowing along the blades equals or exceeds half that available by expanding it at the tips. If the asymmetric mode of rotor operation is to be retained, the author expects to see helicopters driven by turbo-jet engines; a simple analysis shows that such a machine would have a greater range than a shaft-driven machine for the same take-off and useful weights and the same (large) rotor diameters—since the range of a helicopter is usually critical, this is a strong recommendation. However, the use of the turbo-jet engine that commends itself to him particularly is as a supersonic, and hence efficient, engine at the tips of the wings of a machine taking off as a rotorcraft and cruising as an aeroplane, i.e. a Tank propeller ; in view of his advocacy in jet rotors that cease to rotate, it is surprising that he does not show interest in those that cease to eject, i.e. the "Rotodyne" principle. His own contribution to the jet propeller family is the ramprop, a rotor for v.t.o.l. (symmetrical) operation driven by supersonic ramjets or ramrockets : "The major drawback of the ramprop is its awful noise."

The section on atomic energy in jet propulsion was compiled before the first surface vessel with nuclear propulsion had "sailed." As is well known, the United States have not hurried to attain practical experience of the nuclear aircraft, and hence the bulk of the matter is devoted to reactor physics ; the use of reactors in open and closed cycle gas turbines and in rockets is discussed, but at the time of preparation (the latest reference is 1956) Project "Pluto" had not advertised the ready applicability of the nuclear ramjet to strategic bombardment.

The very last section again draws even more than its share of credit for having been completed in 1951, and this is the more remarkable in that it is devoted to "Future Prospects of Jet Propulsion." It is patent that for a treatment of such a topic to be published more than eight years after its compilation is dramatic, but this in fact is far from the principal ground on which one feels that this section deserves to be preserved as a part of the history of engineering ; in this section is developed the thinking that led to the very first triumph over the gravitational field of Earth, the creation of artificial meteors in October, 1957, by accelerating aluminium pellets into space by shaped charges in an "Aerobee" rocket. The mode of thought under consideration is the morphological method, which may be described as identifying all the ways in which different devices for strictly defined function can differ, and then examining every combination of the different cases conceivable for each parameter. To quote one simple example, the reversible processes for converting chemical energy into propulsive power may be either thermomechanical or thermoelectric and either isothermal or adiabatic. The mechanical/adiabatic and the electrical/isothermal are, respectively, more or less well known as the conventional heat engine and the fuel cell. Attention is

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More familiar ground is occupied by the two sections following, devoted respectively to "The Liquid Propellant Rocket Engine" and "Solid Propellant Rockets"; in both cases it is surprising how little of the wearisomely commonplace accounts is noticed in these really penetrating treatments. The practical outlook is again dominant, the discussion of liquid rocket performance dealing, for instance, with the departures from ideal performance due to conical divergence of the exhaust jet, surface friction and flow disturbances in the exhaust nozzle, constriction of the exit area due to boundary layer build-up, jet detachment, heat loss from the hot gas to the cold motor walls, suspended liquid or solid particles in the exhaust jet, and pressure drop in the combustion chamber due to heat release, while the chapter on the internal ballistics of solid motors treats the change of shape of the charge due to pressure gradient along the chamber, acceleration forces, and, particularly, erosive burning. It could be said of both sections that they stop short only at the stage when it would be necessary to consider individual propellant combinations.

A considerably smaller part is perforce played by practical considerations in the section on the ramrocket—the (air) turbo-rocket is given but a footnote, and no index entry, doubtless justifiably in view of the emphasis on high flight speeds. The prospect held out by these still-simple engines of comparing well with the ramjet when far from their best speed is made clear, and the crucial issue of what fuel can be used is not shirked ; while it is admitted that the user would probably insist on using established permutations of fuel and oxidant, most of the performance studies assume a hydrocarbon mono-propellant with a specific impulse of decomposition of 220 seconds. The engine stands or falls by the performance of the combustor, and, the problem of mixing and burning a supersonic and a subsonic stream being out of reach of theory, it is somewhat discouraging that the sub-section on experimental burner results is shorter than all others except the cited references.

A great variety of past, present, and future designs are available for discussion in the section on jet rotors. The author makes clear in his introduction that in his philosophy of engineering, the condition for the survival of any technique is that it shall attain some accepted goal, and his intention is to show that jet rotors promise such a performance. Unfortunately, it is not made easy to follow his thinking, at least in part because of the casual manner of introducing concepts which pages later become vital ; a definition of coning angle, β, subtle beyond the verge of obscurity is used, and hence we later find

$$F_r(\beta) = F_r(0) \cos^3 \beta$$

where F_r is the force exerted by the air on the rotor, which is unwelcome since one expects to fly at coning angles less than that for maximum lift. Reasonably and rightly, great emphasis is given to the severe limitation imposed by the existence of this maximum coning angle and apparent to the pilot as a minimum rotor speed restriction, since it is this limitation that leads to blade tip ballast. The rotor radius at which a jet engine to power the rotor would have the same weight as the required ballast is stated to be the optimum size for a jet rotor, since it is the only size at which the rotor weight is not greater than that of a shaft-driven rotor ; before accepting this, one would wish for assurance that the weight of the ballasted rotor was stationary at this radius. These difficulties, however, do not prevent this section presenting an excellent exposition of the limitations of rotor craft ; it is submitted that the asymmetric rotor, i.e. one providing lift in near-horizontal flight, is perforce low-subsonic because of the severe variation in flow direction that would be experienced by an intake at the tip—a diffuser that would tolerate 4 deg. misalignment at 2000ft per second would limit flight to 95 m.p.h. Despite this obvious prompting, little or no consideration is given to the system in which air is ducted along the blades and burnt at the tips ; considering that the transfer of the engine weight from the tips, where it is useful, to the hull reduces the optimum size intolerably, the author does not even point out that the energy absorbed by the air flowing along the blades equals or exceeds half that available by expanding it at the tips. If the asymmetric mode of rotor operation is to be retained, the author expects to see helicopters driven by turbo-jet engines; a simple analysis shows that such a machine would have a greater range than a shaft-driven machine for the same take-off and useful weights and the same (large) rotor diameters—since the range of a helicopter is usually critical, this is a strong recommendation. However, the use of the turbo-jet engine that commends itself to him particularly is as a supersonic, and hence efficient, engine at the tips of the wings of a machine taking off as a rotorcraft and cruising as an aeroplane, i.e. a Tank propeller ; in view of his advocacy in jet rotors that cease to rotate, it is surprising that he does not show interest in those that cease to eject, i.e. the "Rotodyne" principle. His own contribution to the jet propeller family is the ramprop, a rotor for v.t.o.l. (symmetrical) operation driven by supersonic ramjets or ramrockets : "The major drawback of the ramprop is its awful noise."

The section on atomic energy in jet propulsion was compiled before the first surface vessel with nuclear propulsion had "sailed." As is well known, the United States have not hurried to attain practical experience of the nuclear aircraft, and hence the bulk of the matter is devoted to reactor physics ; the use of reactors in open and closed cycle gas turbines and in rockets is discussed, but at the time of preparation (the latest reference is 1956) Project "Pluto" had not advertised the ready applicability of the nuclear ramjet to strategic bombardment.

The very last section again draws even more than its share of credit for having been completed in 1951, and this is the more remarkable in that it is devoted to "Future Prospects of Jet Propulsion." It is patent that for a treatment of such a topic to be published more than eight years after its compilation is dramatic, but this in fact is far from the principal ground on which one feels that this section deserves to be preserved as a part of the history of engineering ; in this section is developed the thinking that led to the very first triumph over the gravitational field of Earth, the creation of artificial meteors in October, 1957, by accelerating aluminium pellets into space by shaped charges in an "Aerobee" rocket. The mode of thought under consideration is the morphological method, which may be described as identifying all the ways in which different devices for strictly defined function can differ, and then examining every combination of the different cases conceivable for each parameter. To quote one simple example, the reversible processes for converting chemical energy into propulsive power may be either thermomechanical or thermoelectric and either isothermal or adiabatic. The mechanical/adiabatic and the electrical/isothermal are, respectively, more or less well known as the conventional heat engine and the fuel cell. Attention is

LETTERS AND LITERATURE *(Continued)*

drawn to the potential virtues of the mechanical/isothermal combination using what is known in thermochemistry as a Van't Hoff furnace in which reaction and expansion take place alternately as the propellants flow through the motor : it is submitted that " reaction on the flow " not only offers, philosophically, greater useful work, but may prevent rather than cure knock, resonance, and detonation. Electrical/adiabatic conversion, cooling by extraction of current, presented a complete void at the time of writing, which surprised the author because, in contrast to polytropic expansion, it offered success with propellants largely solid or liquid : there is no footnote to tell us whether his pointing out such processes inspired the magnetohydrodynamic generators of today. Morphological analysis of propulsion, the change of relative motions within a given set of bodies, led the author to direct attention to the " interplanetary aeroduct," now called a re-combination ramjet, resulting in a successful demonstration of the recombination of monatomic oxygen at 110km altitude by the dispersal of nitrous oxide from an " Aerobee " in the spring of 1956. The " terrajet " engine seems still to belong solely to such romances as " The Tunnel." This entire section is so attractive scientifically that one wishes it had been rendered easier to follow by using phrases even where one word is strictly adequate, and also by more careful preparation of, for instance, the diagram on page 763 : however, a bibliography of other works by the same author supplements the list of cited references.

It is, unfortunately, necessary to conclude that the index does not do justice to a compilation of altogether exceptional quality.

Chemical Engineering Practice, Vol. II : Works Design, &c. General Editor : HERBERT W. CREMER. Managing Editor : SIDNEY B. WATKINS. Butterworth's Scientific Publications, 4–5, Bell Yard, London, W.C.2. Price 95s.

THIS book is No. II of the twelve volumes which will comprise an encyclopædia of Chemical Engineering Practice. It is issued out of sequence as its publication follows that of Volume 6, but further volumes are in preparation. The abbreviated title which it has been given does not adequately convey the wide field which is covered ; it is, in fact, sectionalised into Works Design, Layout and Execution ; Works Administration ; the Factories Acts and other Legislation ; Works Safety ; and Patents.

It is now accepted that chemical engineering is a technology in its own right and the volumes previously published dealt with physio-chemical principles which are indisputably a part of that technology and with their practical application to chemical plant design and operation. In the widest possible meaning of chemical engineering, which is apparently being followed in this encyclopædia, other technologies are necessarily involved. Thus, the first section of this volume deals largely with civil engineering. If one regards this as background knowledge which a chemical engineer acting as a project manager ought to have, it is very suitably presented and could be most helpful, but it is not, of course, a textbook of civil engineering in the sense that the earlier volumes were textbooks of chemical engineering. One would hope that on the strength of having digested a volume such as this, the chemical engineer will not be tempted to over-rate his competence in other technologies.

Works administration will fall to the lot of many chemical engineers. Even in the chemical industry they will not, however, have a monopoly of it and the quality of their performance will depend upon experience and personal qualities which are supplementary to, rather than a part of, their technological training. The section of the volume which deals with administration is an admirably succinct and readable introduction to a wide subject and it should prove a great help to anyone entering the chemical or other process industry. For outstanding success in management one may have to add something more than can be provided by a statement of sound principles, but, nevertheless, sound principles are the essential basis and one can gather from Dr. Hiscock's contribution many of the factors which have helped towards the outstandingly successful record in management of many parts of the chemical industry.

The section on legislation, covering the Factory Acts, the Alkali Acts and regulations stemming therefrom, presents, within convenient compass, knowledge which is highly desirable for any chemical engineer and essential for those who are to be concerned with plant operation. The fact that almost all chemical processes use or manufacture materials which are potentially hazardous by toxicity, corrosion, fire or explosion, has led to an attitude to safety in the chemical industry which goes beyond what can be ensured by legislation alone. The chapter on Industrial Hazards treats safety on this wider basis and one hopes will help to make more widespread policies which, in much of the industry, have reduced hardship to individuals and led to high corporate morale.

The last section of the volume is devoted to patents. This is a specialist activity but one of which the chemical engineer should have some background knowledge. The aim, as explicitly stated, is to give the chemical engineer enough knowledge of the system to discuss patent problems with the patent lawyer and to understand the nature of these problems. This is done very well and the presentation of what can be a forbidding subject is really interesting.

A Simple Approach to Electronic Computers. By E. H. W. HERSEE, M.A., D.C.Ae. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 12s. 6d.

THE essential information required for understanding what computers do is here presented concisely and lucidly in the space of about 100 pages. To begin with, the author gives instruction in the language the computers themselves understand, and after reading his chapter on the binary code the references to " bits " and " words " which appear in computer manufacturers' specifications become comprehensible. Seven of the ten chapters deal with digital computers. Basic circuits are first described, concentrating on what they do rather than how they do it. This is a welcome change from the kind of description which confronts the newcomer with pulses of mysterious origin proceeding through the computer circuits on missions of unknown purpose. Here, instead, the processes of addition and subtraction are followed step by step with the assistance of block diagrams. Further chapters on computer memory and control lead up to a similar step-by-step examination of a digital computer solving a problem. The author's approach to analogue computers is similar, proceeding through preliminary ideas and the basic forms of amplifier to the solution of a simple problem. The groundwork provided in the book will be a sufficient introduction for many readers to the practical use of computing equipment. Those who wish to go further and study the electronics of the subject will find that a knowledge of its contents will save them much confusion of thought in reading more advanced descriptions.

Books of Reference

Kempe's Engineers Year-Book, 1960. Sixty-fifth edition. Two volumes in case (crown octavo, approximately 3000 pages). Morgan Brothers (Publishers), Ltd., 28, Essex Street, Strand, London, W.C.2. Price 87s. 6d. (90s. post free).—The 1960 edition of this invaluable year-book includes seven sections which have been rewritten with new illustrations, namely : " Electronic Engineering," now enlarged to include industrial electronics and microwave techniques ; " Nuclear Power," a new title which includes details of the U.K. reactors and nuclear fuels ; " Prestressed Concrete," rewritten to cover the advances in this field ; " Naval Architecture," rewritten with new illustrations ; " Railway Signalling," and " Railway Brakes," both rewritten with new illustrations ; " Diesel Locomotives and Railcars," an entirely new title. Other additions to the information include : " Steam Engineering " (text and illustrations dealing with boilers and furnaces) ; " Iron and Steel " (high-temperature steels) ; " Machine Tools " (tube bending machines, cutting tools and coolants) ; " Mechanical Handling " (machine skids and dolly trucks) ; " Flow Metering and Mechanical Testing " (high-pressure flow meters and fatigue testing machines) ; " Water Engineering " (base exchange water softening) ; " Refrigeration " (performance of refrigerants).

The chapters of Kempe's are revised for each edition by specialists in each subject, their names appearing with the title. Each chapter includes a bibliography for the guidance of those who require further data, and the whole book is served by a 120-page index. The eighty-five sections of the year-book cover practically the whole range of engineering and there are obvious advantages in having the principles and practice in almost every branch within the compass of one handbook. Apart from its day-to-day use in providing basic data, there are times when information on an unfamiliar subject is called for without delay, and without research into specialist literature ; on such occasions there may well be a saving in time and effort by consulting Kempe's.

Books Received

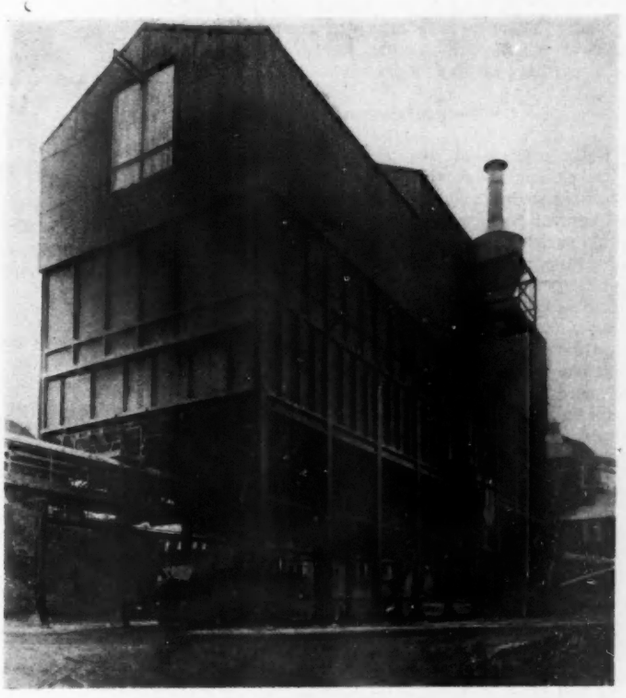
Teach Yourself Naval Architecture. By B. Baxter. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 10s. 6d.

Electrical Circuit Analysis. By K. Stephen. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 30s.

Applied Heat for Engineers. Third Edition. By J.-B. O. Sneeden. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 25s.

The Lead Storage Battery. Fourth Edition. By H. G. Brown. John Sherratt and Son, The St. Ann's Press, Park Road, Altrincham, Cheshire. Price 24s.

Comprehensive Stone Treatment Plant in a Leicestershire Quarry



The installation of handling and treatment plant at Markfield Quarry is noteworthy for the completely automatic control of the batching of stone fed to a "black top" mixing plant. At present thirty to forty 2-ton batches of coated stone can be turned out in an hour. Extension to serve a ready-mixed concrete plant and a stockyard is envisaged.

THE preparation of graded stone aggregates, involving principally crushing, screening and batching operations, has become, over the past decade or so, a highly mechanical business which tends to be concentrated in large plants where automatic control gives the greatest measure of benefit. This trend has been commented upon in earlier articles in this journal, notably in our description of the slag plant at Teesport (see THE ENGINEER, April 18, 1958). Last week we were able to inspect a plant which provides another example of this trend, which is laid out to serve all the various uses to which the stone is put. This plant is at Markfield, between Leicester and Ashby-de-la-Zouch, and is at a quarry operated by the Cliffe Hill Granite Company, Ltd. The rock quarried is syenite, about 1400 tons of which is quarried in a normal day's work. It is used principally as coated stone for roads, ready-mixed concrete, road chippings, aggregates, railway ballast and as a filter medium, though of course there are other uses as well.

The first stage of a comprehensive plant to serve all these needs is now in operation at the quarry. At present it is possible to load lorries directly from storage hoppers, or to batch and mix coated stone using an automatic control system. Future extension of the plant will cater for the other uses by providing a modern ready-mixed concrete plant, and a stockyard of graded stone.

The fundamental unit of the plant is a battery of storage hoppers, with screens above them, which have a total storage capacity of 2700 tons in eleven hoppers. The title illustration shows the hoppers; note the dust-extracting plant.

Stone is won at three faces at the quarry. The primary crusher—a 30in Allis Chalmers gyratory machine—is installed at the level of the intermediate face and is fed directly from the quarry dumpers. It reduces the stone to —6in in size, and has a capacity of 250 tons per hour.

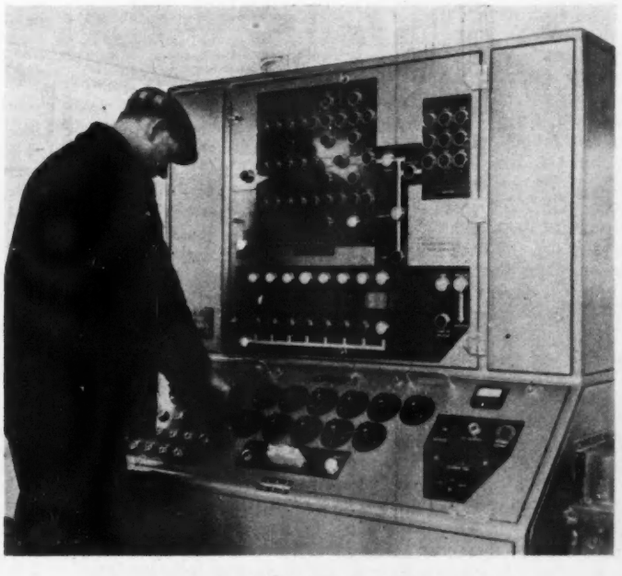
From this primary crusher, a conveyor 500ft long and rising 150ft, carries the stone to a 100-ton hopper grouped with the main plant. After removal of —1¼in stone and dirt by a live four-roll grizzly, the clean stone is discharged into a 300-ton hopper from which it passes to the Nordberg 4¼ft secondary crusher. The undersize from the grizzly is processed into three small grades.

A selector screen is then interposed between the secondary crusher and the main storage hoppers, its purpose being to give flexibility in the production of the various graded sizes. The selector screen classifies the stone into —⅜in, —¾in, —1½in, —2in, and oversize, which is recirculated through the crusher. This selection of sizes enables the appropriate size of stone to be fed to the tertiary crushers without having to use extensive conveyor runs and without having to pass the entire production through the final screens. The selector screen is a Symons horizontal vibrating screen, 5ft wide and 14ft long, discharging its four fractional products into separate bins each of 100 tons capacity, from where they can be conveyed to the tertiary crushers or direct to the final screens. The tertiary crushers are a Nordberg 3ft, producing —⅛in, and a Nordberg 4ft producing —¼in size.

The final screens are situated at the top of the main storage building. Material arriving here first passes a scalping screen which separates the feed into +¾in and —¾in. The +¾in material then passes a single-deck vibrating screen, fitted with three meshes, which separate it into —1in, —1¼in, —1½in, and —2in, each size discharging into its respective storage hopper below.

The —¾in material passes first over a double-deck screen which takes out the dust, and —¼in stone, and then over a single deck which takes out —⅜in, and —½in. These four sizes and the —¾in stone are also discharged into storage hoppers below.

The entire storage plant which is 108ft long by 30ft wide by 40ft high has eleven hoppers, seven of 300 tons and four of 150 tons capacity. The hoppers have pneumatically-operated discharge gates to load lorries directly.



Central control panel serving the coated stone plant

THE COATED STONE PLANT

A constant-rate feeder—an "Accra batch" feeder—is also fitted below each hopper of the main storage plant, set to deliver stone at a rate of 120 tons per hour on to a conveyor. The accuracy of these feeders is stated to be one second, and the maximum "open" time is set at ninety-nine seconds. The conveyor picks up batches of stone which are then carried to a silo where eight separate batches may be stored using a twelve-position indexing chute. From the silo, each batch is taken as required to the check-weigher, heater and mixer of the coating

plant. There is one mixer in the coating plant, which can handle thirty to forty 2-ton mixes in one hour.

Control System

The interest of this section of the plant lies principally in the control system. The following operations are all controlled from a central panel: first, stone is drawn from the various hoppers in measured amounts by timed operation of the feeders following the specification of the particular batch required; the "batch" of stone is conveyed to the silo, where selection of the position of the indexing chute ensures its delivery into the first empty bin. Of the twelve bins available in this silo, two are spares, the ninth is reserved for the "ready mix" concrete plant soon to be installed, and the tenth is for lorry loading. These ninth and tenth positions are selected by a switch on the main console, which is illustrated herewith.

There is also a "slave" panel for the mixer operator, which duplicates indication of the bin selected by the indexing chute for the particular batch concerned. The mixer operator then releases the batch from the silo when he is ready to process it, and this operation (emptying the bin in the silo) is indicated at the main control panel.

In the illustration of the control panel, the group of dials in the central, lower, part of the console can be set to time the feeders, and hence define a "batch" and check it by a "totaliser." This manual setting is not necessary in normal operation however, and corresponding instructions are given by a "plug-in" block, which can be seen in position in front of the dials. A set of thirty of these blocks is kept corresponding to all the coated stone mixtures normally required; a limitation of forty-eight formulæ exists in the equipment.

Having secured the appropriate block in the console, the number of batches required is set on the right-hand control and then the whole sequence initiated. The indicator lights in the upper section of the upper panel show "high" and "low" levels in each hopper, indicate which hoppers are discharging (all the hoppers selected discharge simultaneously) and which conveyors are carrying stone. The lower lights show which of the eight bins in the silo have batches stored in them. The left-hand section of the lower panel, which the man is using, is for manual control of the feeders for such purposes as stocking out. Various interlocks which prevent mal-operation of the automatic sequence do not apply to this manual control. Loading lorries from the hoppers is done by the lorry drivers, and is quite separate.

A principal problem in designing the control console was the exclusion of dust, and its interior is slightly pressurised. For operation of the plant one man is needed at the console, and two at the mixer. Previously five men (two of them lorry drivers) and two lorries were needed to feed the mixer from the hoppers.

Contractors

The main contractor for the treatment plant described here (i.e. selector screens, final screens and storage bins, conveyors, and batch storage silo) was Thomas W. Ward, Ltd., that firm's subsidiary, the Ensign Conveyor Company, Ltd., handling the conveyors and the batch storage silo. The control system and console were subcontracted to Ericsson Telephones, Ltd.

Concrete Plant at Klang Gates Dam in Malaya

By J. CONACHER, D.L.C. (Hons.), A.M.I.Mech.E.*

The concrete for Klang Gates Dam was cooled at the batching and mixing station by air-cooling the coarse aggregate, and cooling the mixing water and adding a given proportion of ice to it. This plant is thought to be the first incorporating these methods of cooling supplied from the United Kingdom. Its design and construction are briefly described.

THE Klang Gates Dam, Kuala Lumpur, Malaya, which has recently been completed, is the first stage of a comprehensive scheme to control flood water in Malaya and to conserve water during the rainy season. The dam was designed by the U.S. Bureau of Reclamation and built by the Public Works Department of Malaya at a cost in excess of £1,600,000. It is able to impound 4000 million gallons of water, and during the dry season its reservoir will supply both Kuala Lumpur and Petaling Jaya with 32 m.g.d. It is estimated that the present scheme will be adequate until 1972. Construction took three years, of which seventeen months were required for placing the concrete. The dam is over 100ft high with a crest length of 450ft.

When building mass concrete structures under high ambient temperature it is necessary to limit the placing temperature of the concrete to avoid the dangers attending rapid stiffening of the concrete and to reduce the thermal contraction of the concrete,

Table I—*Basic Data for Cooling Concrete Materials*

Temperature of concrete at mixer, deg. Fah.	48
Moisture in sand, per cent	2
Moisture in stone, per cent	1
Temperature of feed water, deg. Fah.	80
Ambient temperature (average), deg. Fah.	85
Temperature of cement, deg. Fah.	85
Temperature of sand, deg. Fah.	85
Temperature of stone, deg. Fah.	85
Specific heat of stone, deg. Fah.	0·22
Specific heat of sand, deg. Fah.	0·22
Specific heat of cement, deg. Fah.	0·22
Output of concrete per hour, cubic yards	22
One 1 cu. yd. mixer in operation absorbing, b.h.p.	12·5
Weight of concrete per cubic yard, lb	4200
48 deg. Fah. concrete at mixer only required where maximum aggregate employed is 6in or 3in.	
Placing of concrete, hours per day	12
Minimum cooling time for aggregates, minutes	90

which, if these measures were not taken, would result in cracks developing as setting occurred. There are two main systems used to control the temperature, namely "pre-cooling"—cooling the materials of the concrete mix before and when mixing, or "after cooling" by installing pipes in the actual structure through which a cooling medium is pumped to limit the temperature in the mass concrete.

The system used at Klang Gates Dam was the first of these alternatives, namely "pre-cooling." The coarse aggregates were cooled by cold air in the bin compartments, and in addition the mix water had to be supplied partly as ice and partly as chilled water. It was specified that the temperature of the concrete should not exceed 48 deg. Fah. The placing temperature was specified as 50 deg. Fah. and 2 deg. Fah. was allowed for temperature rise when conveying the concrete from the plant to the dam. Table I gives the agreed design data.

* Divisional Director, Blaw Knox, Ltd.

Four concrete mixes were used with 6in, 3in, 1½in and ¾in maximum aggregate sizes. The mix employing 6in stone was used for the dam and spillway bucket. To calculate the various refrigeration loads average weights of sand and coarse aggregates were selected from the mixes as given in Table III.

Table III—*Constituent Weights of Concrete Mixes*

Mix	Maximum aggregate, in	Cement, lb	Water, lb	Sand, lb	Aggregates, lb
1	6	250	150	913	2887
2	6	350	210	885	2755
3	3	375	187	1038	2600
4	3	455	228	1003	2515

The maximum refrigeration load for aggregate cooling occurred, as will be seen from Table III, for the No. 1 mix when the total weight of aggregate was 2887 lb per cubic yard, but individual loads occurred for the various sizes of aggregates and had to be taken into account when designing the air cooling system. Table II gives the air cooling loads for the coarse aggregates.

It was necessary to determine the fan horsepowers so that these powers could be allowed for in the heat calculation. The following example is given to illustrate the refrigeration load calculations for air cooling.

Coarse Aggregates.

$$\frac{26{,}420 \text{ B.Th.U} \times 22 \text{ cu. yds./hour}}{12{,}000 \text{ B.Th.U per ton refrigeration}} = 48{\cdot}5 \text{ TR}$$

Fan Load.

$$\frac{57{\cdot}6 \text{ b.h.p.} \times 2545 \text{ B.Th.U/b.h.p.}}{12{,}000} = 12{\cdot}25 \text{ TR}$$

60·75 TR

Plus 25 per cent to cover air infiltration and insulation losses... ... 15·2

75·95 TR

The above calculation gives the maximum cooling load for aggregates, but it was necessary to make similar calculations for the individual aggregates since for the different mixes specified these loads varied.

Table II—*Air Cooling Load for Aggregate per Cubic Yard*

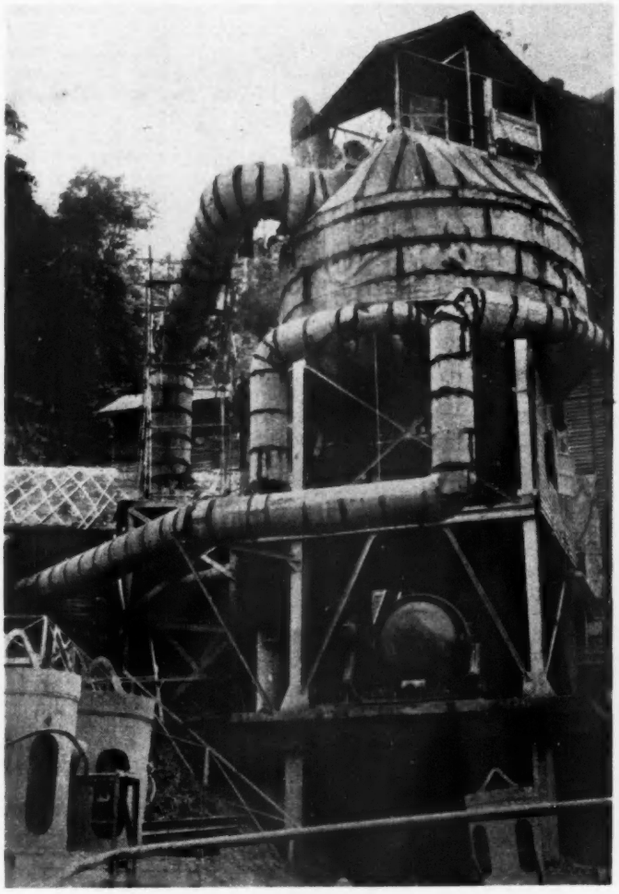
Mix	Maximum aggregate, in	Dry weight, lb	Surface moisture, lb	Initial temperature, deg. Fah.	Final temperature, deg. Fah.	Specified heat, stone	Specified heat, water	B.Th.U per cubic yard
1	6	2887	28·87	85	45	0·22	1·0	26,420
2	6	2755	27·55	85	45	0·22	1·0	25,380
3	3	2600	26·0	85	45	0·22	1·0	23,810
4	3	2515	25·15	85	45	0·22	1·0	23,025

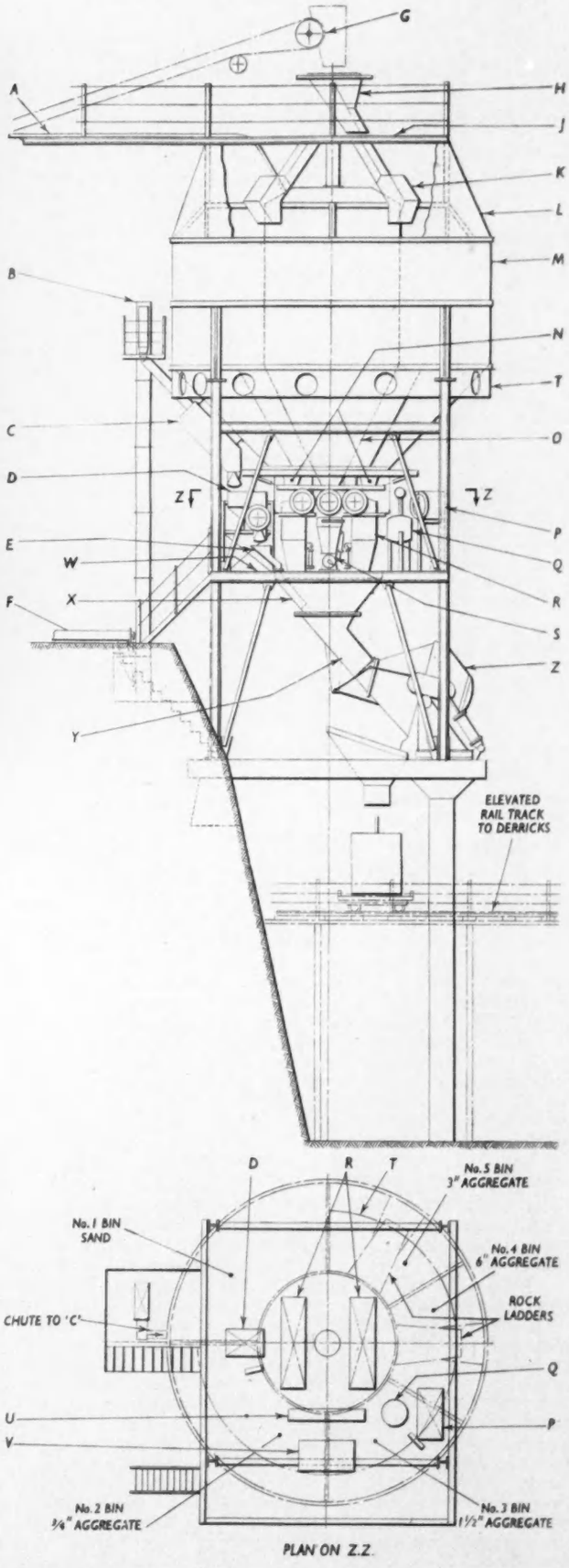
Table IV gives in tons the maximum individual aggregate cooling loads for which the air cooling batteries were designed:

Table IV—*Maximum Design Loads in Tons Refrigeration for Each Size of Coarse Aggregate*

	6in	3in	1½in	¾in	Totals
Stone and surface water cooling	12·125	12·25	12·25	19·2	55·825
Fan motor...	2·76	2·76	2·04	4·66	12·22
Losses... ...	3·72	3·75	3·57	5·96	17·00
Totals... ...	18·605	18·76	17·86	29·82	85·045

Again to illustrate the method of calculating the additional cooling loads imposed by





PLAN ON Z.Z.

A—4in bore cement delivery hose.
B—Flake-ice elevator, electrically-driven, with anti-run back gear, platforms and access ladder. Capacity : 2 T.P.H. Centres : 28ft.
C—Patch bin for flake-ice storage, with high level indicator and electro-pneumatically-operated radial discharge gate. Capacity : 450 lb.
D—Flake-ice weigh hopper (to weigh up to 150 lb) with pneumatically-operated radial discharge gate.
E—Flake-ice chute to dry batch collecting hopper.
F—Flake-ice screw conveyor, driven from ice elevator. Capacity : 2 T.P.H.
G—Troughed belt aggregate conveyor, electrically-driven, with anti-run-back gear, head chute. Capacity : 60 cubic yards per hour.
H—Swivelling turnhead, manually operated.
J—Superstructure platform.
K—Fixed chutes with end deflectors.
L—Plenum head and cooling air return to refrigeration plant.
M—25ft dia., two-ring bin, comprising : one central cement compartment of 50 tons capacity ; two aggregate compartments of 50 cubic yards capacity ; three aggregate compartments of 34 cubic yards.
N—Aggregate compartments with electro-pneumatically-operated radial discharge gates, and manually-operated slide-type cut-off gates.
O—Cement compartment, with electro-pneumatically-operated rotary cement valve, manually-operated rack-and-pinion slide-type cut-off gate, manhole cover, ventilator and high level indicator. Bin neck fitted with low pressure aeration jets.
P—Additive dispenser.
Q—Water tank, electro-pneumatically operated.
R—Aggregate weigh hoppers with electro-pneumatically-operated radial discharge gates.
S—Cement weigh hopper with electro-pneumatically-operated rotary cement valve.
T—Cold air ducts to aggregate compartments. Four to No. 2 bin, two each to bins Nos. 3, 4 and 5.
U—Dial panel, comprising : two 18in dials calibrated up to 4000 lb for aggregates ; one 18in dial calibrated up to 1000 lb for cement.
V—Operating panel.
W—Operating platform.
X—Dry batch collecting hopper, with special ice chute.
Y—Chute to mixer with link-operated retractable snout.
Z—One 1 cubic yard tilting mixer.

Batching and mixing plant with refrigeration equipment at Klang Gates dam in Malaya

the cooling of sand, cement, moisture in the sand, and the heat input of the mixer motor, the following calculation is given for mix 1, Table III.

Sand :

913 lb × (85–48) × 0·22 = 7,450 B.Th.U./cu. yd.

Cement :

250 lb × (85–48) × 0·22 = 2,040 B.Th.U./cu. yd.

Moisture in sand (2 per cent) :

18 lb × (85–48) × 1 = 666 B.Th.U./cu. yd.

10,156 B.Th.U./cu. yd.

Plus 10 per cent for losses 1,016

Mixer motor 797 B.ThU/cu. yd.

11,969 B.Th.U/cu. yd.

Therefore the cooling demand at the mixer in the form of chilled water and ice was 11,969 B.Th.U per cubic yard. The water to be added to the mix was 150 lb less (29 lb in the aggregate and 18 lb in the sand), viz. 103 lb. This 103 lb of water was delivered to the mixer in certain proportions of chilled water at 35 deg. Fah. and ice at 32 deg. Fah. with 144 B.Th.U. per lb of latent heat, determined thus :

$11{,}969 = x$ lb ice $[144 + (48 - 32)] + y$ lb water $(48 - 35)$; and $x + y = 103$. Hence $x = 72 \cdot 3$ lb ice per cubic yard, and $y = 30 \cdot 7$ lb per cubic yard of chilled water.

Similar calculations show that the maximum ice requirement occurred for mix No. 3 (Table III) this being 85 lb per cubic yard, and the maximum chilled water for mix No. 4 (Table III) being 100 lb per cubic yard. Thus :

Maximum chilled water requirement per hour

$$= \frac{100 \times 22}{10} = 220 \text{ gallons}$$

Maximum ice requirement per hour

$$= 85 \times 22 = 1870 \text{ lb}$$

From the foregoing the concurrent refrigerating loads are : Air cooling of aggregates, 75·95 TR. Water cooling 220 gallons from 80 deg. Fah. to 35 deg. Fah. plus. Heat gain from insulation, 10 TR. Ice making 1870 lb per hour or 10 Imperial tons per twelve hours. For economy of operation ice was manufactured for twenty-four hours per day and stored. Having described the methods used to calculate the refrigeration load we can now proceed to describe the batching and refrigeration plant in greater detail.

Batching and Refrigeration Plant

The illustrations on page 473 give a good general idea of the plant. Four separate refrigeration plants were incorporated in it with the following duties :

1. Air cooling for aggregates. 2. Water cooling. 3. Ice manufacture. 4. Ice storage.

Aggregates were brought by road and discharged into a 5-ton receiving hopper fitted with a vibratory feeder which fed the material on to a 20in wide, 72ft centres belt conveyor. The batching plant was erected at a lower level taking advantage of the site to economise on the length of conveyor. After the concrete was mixed it was discharged into 1 cubic yard roller gate buckets mounted on trolleys running on rails on a gantry to a position where they could be picked up by derrick cranes and the concrete placed in the dam.

Cement was delivered in bags as bulk cement was not available ; bags from the store were broken into a 7-ton receiving hopper fitted with airslides. From this hopper the cement was pneumatically conveyed to the bin through a 4in diameter pipeline, using an " Auto-Airflow " activator, an automatic device which, in this instance, had a capacity of 10 tons per hour.

The bin of the plant was 25ft diameter with six compartments, two of 50 cubic yards capacity for sand, three each of 35 cubic yards capacity for 1½in, 3in and 6in graded aggregates and one 50-ton central cement compartment. The aggregates were weighed in separate weigh hoppers, and the cement in another weigh hopper. The weigher feed and discharge gates were operated by pneumatic rams from electric push buttons at the control panel. The cement feed and discharge valves were similarly operated. A dribbling final feed gave accuracy in weighing. The mixer was a 1 cubic yard tilting mixer which discharged into a wet collecting hopper.

The cold air inlet ducts to the coarse aggregate compartments can be seen in the illustrations as can the steel plating covering the top of the bin and forming a plenum chamber for collection of the air after it had passed through the aggregates and cooled them. The cork insulation around the bin, plenum chamber, cold air inlet ducting and air outlet ducting may also be noted. Each separate coarse aggregate compartment in the bin had its own inlet ducting for cold air, but there was a common air return duct to the refrigeration plant.

Ice was reclaimed from the ice store by an open screw conveyor which delivered the ice into another screw conveyor driven from the tail shaft of the totally enclosed bucket elevator. The motor starter for the ice store conveyor was interlocked with the elevator motor ; it was arranged to cut-off when the ice batch bin at the mixing plant was full, and to restart when the bin was empty, under the control of diaphragm high and low level switches in the batch bin. The elevator ran continuously to ensure that the buckets would be completely emptied. The ice batch bin had a pneumatic-ram-operated radial gate controlling the discharge of the ice into a weigh hopper. After weighing, the ice was discharged into the common collecting hopper for the weighed materials.

The chilled water was measured volumetrically, in the vertical water tank which could be set accurately by a graduated indicator. Discharge depended upon a pneumatic-ram-operated valve with push-button control at the panel.

Four separate centrifugal fans were used to deliver air at 35 deg. Fah. to the aggregate bins. The air was cooled by cooling coils placed in the respective inlet ducts. Ammonia was delivered to the coils by two liquid pumps with a further pump as a standby. The compressors were two 9in bore by 9in stroke twin-cylinder, single-acting enclosed ammonia compressors, each driven from a 110 h.p. slip ring motor through vee-belts. The remainder of the refrigeration plant for air cooling consisted of a shell and tube multi-pass horizontal condenser, 20in diameter by 16ft long, condenser water pumps and a low-pressure liquid receiver. All the cooling coils were laid out for " hot gas defrosting," with water sprays to wash off stone dust.

A Baudelot chilling system was used for the mix water, consisting of a galvanised steel tank over which was mounted a galvanised steel cooling coil. Water was recirculated by a vertical-spindle pump over the cooling coil and returned to the tank. A further pump delivered the chilled water to the mixing plant and to the ice plant. The compressor was a 5in bore by 5in stroke twin-cylinder ammonia compressor driven by a 20 h.p. slip ring motor, and the condenser was a 15in diameter by 7ft long horizontal multi-pass shell and tube condenser, this plant being automatically controlled.

Ice for the concrete mix was made to meet the maximum twelve hour daily requirement, but to economise on capital cost was produced over a twenty-two hour day. Four flake ice machines were installed, which froze the ice in ribbon particles, in which form the ice most readily melted when added to the mix water. The refrigerated ice store was immediately under the flake ice machines so the ice could be transferred to the store by gravity, and reclaimed as described above. There was a small automatically-controlled compressor in the ice store, operating on steel pipe direct expansion coils. The remainder of the ice-making refrigeration plant comprised a twin-cylinder ammonia compressor of 7½in bore by 7½in stroke, driven by a 70 h.p. slip ring motor, a 15in diameter by 9ft shell and tube multi-pass horizontal condenser and pumps.

The plant described above is the first " precooled " concrete plant to be designed and supplied from this country. The method of air cooling was selected because of its convenience and lower cost compared with alternative ways of precooling the ingredients for concrete. It is not possible to use ice with the mix above certain proportions and if the amount necessary is too large or the refrigeration load too great then cooling of the sand and cement has to be considered. One method which has been used successfully for these materials is to utilise a hollow flight screw conveyor to agitate them, thus placing them in intimate contact with the outside of the flights, whilst continuously pumping a refrigerant through the hollow flights. A method for cooling the sand which was used during the construction of the Vaitarna Dam in Bombay, was to convey the sand on slowly moving conveyor belts, through an insulated house in which the temperature was maintained just above freezing, the sand also being turned by ploughs during its passage.

The contract for designing and supplying the plant at Klang Gates Dam was awarded to Blaw Knox, Ltd; the supply of refrigeration equipment was sub-contracted to York Shipley, Ltd.

Rules for Oil Tankers

Lloyd's Register of Shipping has published additions and amendments to the current rules, including, in particular, new rules for oil tankers. The society has classed oil tankers for the past seventy-five years, and over thirty years ago introduced rules specifically relating to this class of ship. Since then the size of such ships has increased and necessitated an extensive revision of the rules and this was made in 1949 when the upper limit in length was set at 620ft. The scantlings adopted were based on a series of simple parameters which did not take account of the effect of the design of the tanker on the bending moment to which it was subjected in service. To-day oil tankers are built with lengths up to 900ft, and in formulating the new rules the Society has taken into account the relation between design and stresses when determining the scantlings. The rules, in which tables have been largely dispensed with in favour of formulæ, will apply to all sizes of tankers and will encourage designs having favourable strength characteristics. Furthermore, they allow greater flexibility in application and lay special weight on loading schemes. The application of the revised rules becomes compulsory on July 7, 1960.

Boilers at Little Barford "B" Power Station

WE have received from the manufacturers some details of the Nos. 5 and 6 boilers at Little Barford "B" power station; this information may be of interest, taken in conjunction with the article published in our issue of February 5, 1960, page 226.

These two boilers were designed and built by Foster-Wheeler, Ltd., 3, Ixworth Place, London, S.W.3. Each boiler has a maximum evaporation of 550,000 lb per hour at a pressure of 950 lb per square inch at the superheater outlet, and a final steam temperature of 925 deg. Fah., and is a single-drum, natural-circulation water-tube unit with a water-cooled combustion chamber, having a two-stage horizontal drainable and ventable convection-type superheater, a non-steaming economiser and an air heater.

Each boiler is fired with pulverised fuel fed to intervane-type burners supplied from two Foster-Wheeler type ball mills and their associated coal feeders, classifiers, exhausters and distributors. Oil-fired burners and ancillary equipment are provided for lighting up. Automatic combustion and final steam temperature control arrangements are fitted, together with steam purity recording equipment. The combustion chamber of each boiler is of sufficient height to ensure substantial cooling of the gases before they enter the superheater enclosure, and is water-wall cooled on the front, rear, roof and sides, and is also provided with a water-cooled dry bottom.

All steam generation takes place within the tubes forming the combustion chamber, and this allows a non-steaming economiser to be provided without the use of any convection generating surface. The furnace slag screen and secondary superheater tubes are so pitched to ensure maximum protection against slag build-up at these critical points. The steam and water drum is 5ft 6in internal diameter and is made from seamless forged mild steel, with manholes at each end and machined overall. Water from the drum flows through feeder tubes to a downcomer main, which in turn delivers to four headers at the base of the combustion chamber. The side walls of the combustion chamber are formed by closely pitched tubes connecting the lower side wall headers to upper headers from which riser tubes discharge the steam and water mixture to the drum. The front and rear walls consist of similarly close-pitched tubes running from the lower headers direct to the drum.

Condenser - Type Superheat Control.—The superheater of each boiler is of the convection multi-looped variety, having primary and secondary sections with inlet, intermediate and outlet headers, the primary section being sited in the zone of the lower gas temperature, and the secondary section in the hotter zone immediately behind the slag screen. The primary inlet header, which receives the saturated steam from the drum, is the condenser control header for maintaining the desired steam temperature and is equipped with two tube bundles through which flows a controlled portion of the feed water, this water by-passing the economiser. Positive control of the final steam temperature at 925 deg. Fah. from 440,000 lb per hour evaporation to full load is ensured by means of this Foster-Wheeler condenser control, in which some of the steam entering the primary superheater tubes is condensed and has to be re-evaporated before superheating can take place. By varying the quantity of feed water passing through the header condensers and the amount of condensate which is so formed and requires re-evaporation, the final steam temperature is controlled. This method of superheat control, which is completely automatic, avoids contamination of the steam and only small quantities of by-passed feed water are required. Details of this superheater condenser control header and the flow diagram are shown in the accompanying illustrations.

Economisers.—The economiser of each boiler is of the cast iron gilled tube type manufactured by E. Green and Son, Ltd., of Wakefield, is located below the superheater and has plain tube risers lining the side of the superheater space. Two inlet headers, one on either side and at the bottom of the economiser, receive water from the feed main and are connected to the gilled economiser elements which form two interlaced horizontal banks. The tubes of these two separate banks are each welded to bifurcated branches to discharge into two plain tubes to form risers; these riser tubes line the right and left-hand walls of the superheater space and are connected to two upper headers which in turn feed to the boiler drum at their respective ends.

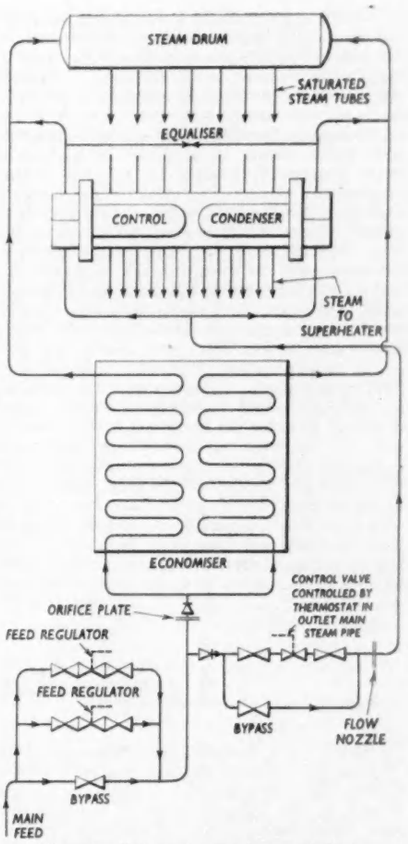
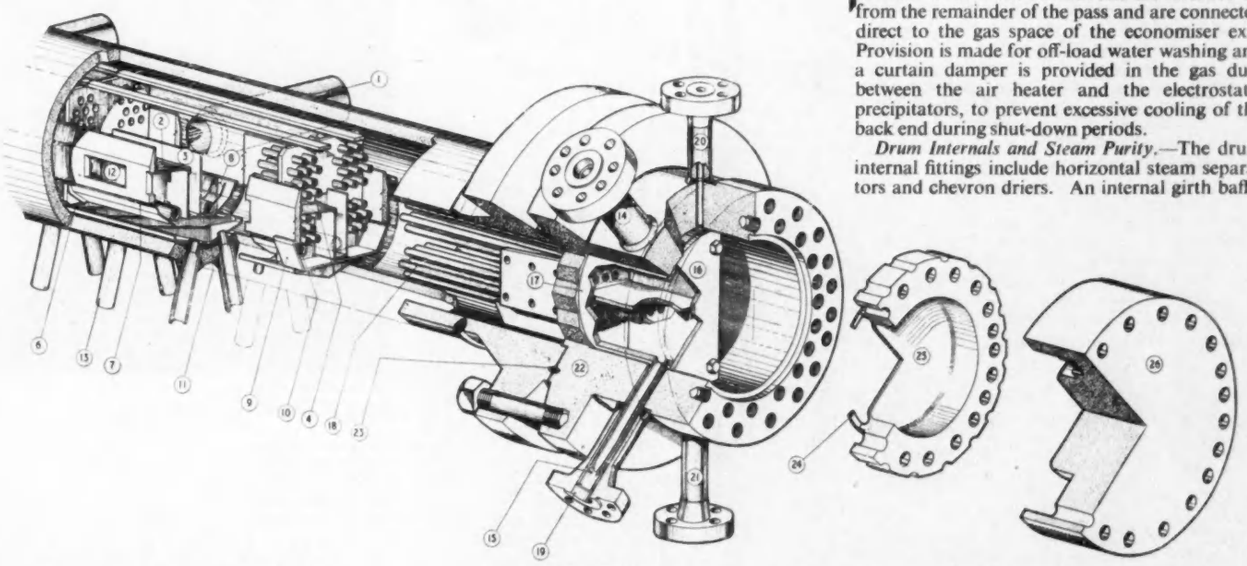


Diagram of steam temperature control at Little Barford "B" power station

Air Heaters.—The air heater fitted to each boiler is a tubular assembly designed to give counter-current gas and air flows. The tubes are arranged in three vertical passes, the gases flowing through the tubes with the air flow across the tubes. To maintain the temperature of the cold end of the heater above the dew-point of the gases at low loads, the first four rows of these tubes at the air inlet end are screened off from the remainder of the pass and are connected direct to the gas space of the economiser exit. Provision is made for off-load water washing and a curtain damper is provided in the gas duct between the air heater and the electrostatic precipitators, to prevent excessive cooling of the back end during shut-down periods.

Drum Internals and Steam Purity.—The drum internal fittings include horizontal steam separators and chevron driers. An internal girth baffle



1—Saturated steam tubes from boiler primary steam drum.
2—Tray.
3—Cascade trough.
4—Filler plate.
6—Distribution tray with sleeves and diagonal baffle plates (one each per superheater tube).
7—Collector plate.
8—Wires.
9—Watertight cradle bottom.
10—Distributor tube (high level, short).
11—Distributor tube (low level, long).
12—Steam admission port.
13—Stubs for primary superheater elements.
14—Water inlet branch.
15—Thermal sleeves in water inlet and outlet branches.
16—Cover plate for bonnet.
17—Bonnet welded inside water box.
18—U-tube bank.
19—Water outlet branch.
20—Vent branch.
21—Drain branch.
22—Water box body.
23—Soft iron joint ring.
24—Soft iron joint ring.
25—Copper-plated mild steel diaphragm.
26—End cover plate.

Superheater condenser control header

follows the contour of the lower half of the drum and is secured by steam-tight connections to two slotted horizontal longitudinal plates fixed to each side of the inner face of the drum. The riser tubes from the combustion chamber water walls discharge their steam and water mixture to the annular space between the drum shell and this girth baffle, thence to a battery of horizontal steam separators arranged on the two slotted longitudinal plates. The velocity of the steam and water mixture swirling around the periphery of the horizontal steam separator separates the water from the steam, the water being discharged to the water in the drum through an outlet port and the steam passing to the steam space through holes in the side plates of the separator. Water which is not discharged through this main water outlet port passes through a perforated grill and is led to an auxiliary port beneath the water level in the drum. Curved plates are provided at the main water outlet to allow the water discharge to enter the drum water at its surface with the minimum of disturbance, whilst the perforated grill and its auxiliary water discharge port prevent water recirculating within the separator and disturbing the steam flow. Banks of integral driers consisting of rows of staggered chevron plates are located in the head of the steam space, and the steam passing through them to the steam outlet pipes is finally freed of suspended moisture. Other drum internals consist of internal feed pipes, water sampling pipe, chemical dosing pipe, &c.

Pulverised Fuel Burning System.—Two Foster-Wheeler double-ended ball mills are provided per boiler for pulverising the coal, together with the necessary feeders, classifiers, exhausters and distributors. The ball mills are of the double classifier type, in which the coal and hot air enter at each end of the mill and the pulverised fuel, in suspension, leaves at both ends of the mill. This arrangement has the advantage of predrying the coal before entry into the mill. The mill is always run under suction. Two classifiers of Foster-Wheeler design are provided for each mill, these classifiers rejecting oversize particles of coal and ensuring that the coal-laden air stream that leaves the classifier carries only such coal as meets the fineness requirements. A by-pass damper is provided when it is desired to increase the amount of coal leaving the classifier and when a reduction of coal fineness can be tolerated.

Two forced-draught and two induced-draught fans serve each boiler, one i.d. and one f.d. fan forming part of each complete mill group. Eight 30in intervane pulverised fuel burners are fitted to each boiler, each burner having an oil-fired burner passing through its inner sleeve for lighting-up purposes. Soot-blowers are fitted and provision is made for water washing.

Large Tower Crane

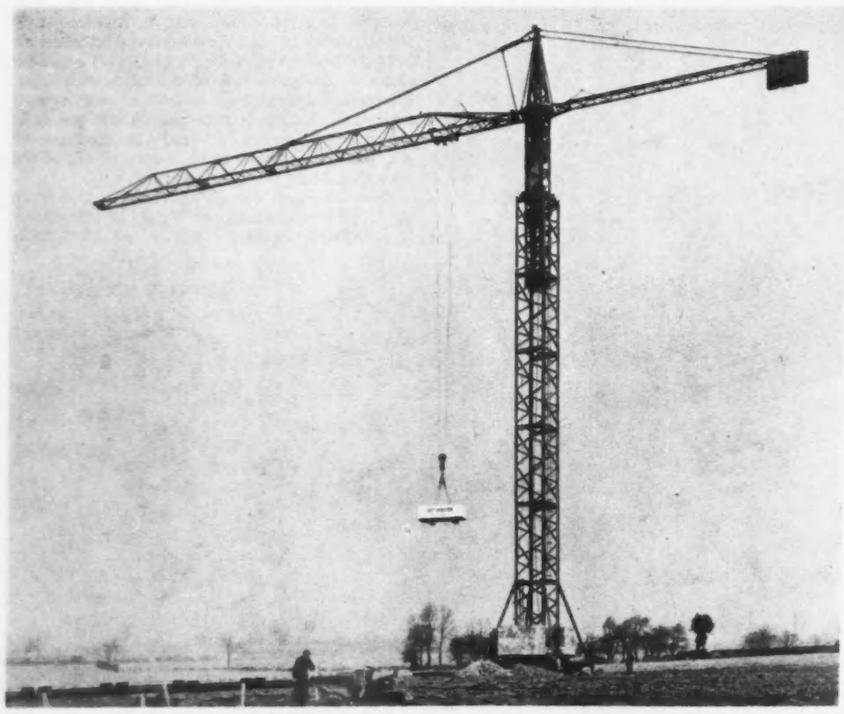
THERE was recently demonstrated at the Kingsbury depot of the George Cohen "600" Group, Ltd., Wood Lane, London, W.12, the largest of the Pingon range of tower cranes now being built. This self-erecting "P200" crane when used with the maximum height of tower has a free height of about 185ft under the hook, and it can be fitted with a 131ft, a 95ft or a 74ft long jib. With the 131ft jib the machine can handle from 15 metric tons at 39ft 6in radius to 4 metric tons at 131ft radius; with the 95ft jib from 15 metric tons at 44ft 6in radius to 6·6 tons at 95ft radius; and with the 74ft jib from 15 metric tons at 49ft radius to 9·5 metric tons at 74ft radius.

The crane, to be seen in our illustration, has a rail-mounted base with four three-wheel bogies. In each of these bogies one wheel is driven through gearing by a 4 h.p. motor and the other two wheels are supported from the frame on an articulated beam to provide for track deflection and ensure that all three wheels remain in full contact with the rail when travelling. At diagonally opposite corners of the base frame the bogies are carried on heavy box-section beams, which are free to slide on roller supports in the main transverse members. This form of mounting compensates for gauge variations in the track and the crane can be traversed round track curves down to 19ft 8in radii. The maximum travelling speed of the crane is 70ft per minute. Some 50 tons of ballast in the form of small concrete blocks is carried on the tower base frame.

The main mast is a box structure just over 8ft square made up in sections having an effective length of 18ft 4in. Each section consists of two side panels which during erection are placed on opposite sides of the mast and coupled by bolted cross bracings which form the other two sides. The jib and counter-jib are mounted on a short inner mast carried within the main mast structure and within which it can be raised. The main mast thus provides a climbing frame in which the inner jib mast can be raised to make the crane self-erecting. The jib and counter-jib are supported horizontally on a slewing ring which encircles the inner mast to the top of which the main bracings are attached. The hoisting rope is carried along the jib on a trolley driven by a two-speed 8 h.p. motor at 125ft or 62ft 6in per minute. A counterweight of 9 tons 18 cwt is mounted on the counter-jib. An 80 h.p. hoisting motor is used to raise loads of up to 4 tons at 196ft per minute and over 4 tons at 65ft per minute on four falls of rope. At both speeds lowering is carried out under power, but a special brake release control is provided to enable the inching of loads when required.

A two-speed, 15 h.p. slewing motor gives one complete revolution of the jib in seventy-three seconds at high speed, the lower speed taking twice this time. Speed changes can be effected while slewing, and by beginning the motion at low speed, changing to high speed for the main arc of slew and again reducing to low speed before the motion is completed, excessive torque on the mast when handling large loads is avoided without sacrificing the high speed of the crane.

Duplicate controls are provided, one set being situated in a cabin in the inner mast from which a clear view is obtained over the whole working area of the crane. The other set is mounted on a portable panel which can be carried by an operator on the ground. These controls are of simple push-button design, as can be seen in the above illustration. All of the driving motors incorporate electromagnetic brakes which are automatically applied when a control button is released. An overload alarm system gives visual and audible warning if attempts are made to handle excessive loads, and if these warnings are ignored the motors are automatically cut out. The crane is not "locked" by an overload and the lowering and trolleying-in controls remain operative so that a load can be brought back to a safe radius, and/or lowered to the ground without re-setting the controls.



Tower crane with a free height of 185ft below the hook and capable of handling from 15 metric tons at 39ft 6in radius to 4 metric tons at 131ft radius

Portable push-button control panel of tower crane

SHORTER REPORTS

Earnings in the Engineering Profession

THE following statement on the Report of the Royal Commission on Doctors' and Dentists' Remuneration has been issued by the Engineers' Guild. An extract from the Report and our comment upon it appeared in last week's issue.

The comparative figures for professional earnings by the members of ten leading professions in Great Britain, which have now been published in the Report of the Royal Commission on Doctors' and Dentists' Remuneration, show how disastrously wide is the gulf between theory and practice in the attitude of the community towards the engineering profession.

In the view of the Government and its advisers, widely expressed for several years past, sufficient numbers of professional engineers are essential to the continued prosperity of the country: the numbers required are increasing steadily and this increase is likely to continue at least for the next ten years; over the whole profession, the supply has never yet been sufficient to meet the demand and is not expected to do so in the immediate future. In these circumstances it would be natural to expect the engineering profession to be respected and its members well rewarded for their services; instead the figures show that not only is it poorly remunerated but that it stands in public esteem, if levels of payment constitute any guide, among the most humble of the professions to-day. The consequences of the present situation, to which the Guild has repeatedly drawn attention, must affect the quality as well as the quantity of new entrants to the profession, and must also limit the opportunities which the profession is given to serve the community to its full capacities.

Although the graphs published in the Report appear to indicate the medical profession as generally occupying a superior economic position compared with the other professions, the Commission see no obstacle in this to their concluding that earnings in the medical profession are too low. In such circumstances, and particularly if the Commission's recommendations are accepted, early consideration by the Government of the economic problems confronting members of the engineering profession is essential. The Commission's proposal for the appointment of a standing committee to keep the remuneration of doctors and dentists under review in the future, deserves sympathetic consideration as being one of the few instances of constructive thought about how professional salaries shall be determined in this country. The proposal avoids the serious disadvantages which the Guild believes are inevitably created for professional people by collective bargaining machinery, and it may well be capable of extension to other fields of employment in which such machinery operates at the present time. The Guild accordingly welcomes the proposal and will be glad to co-operate in any consideration which may be given to its wider application.

Highland Water Power

THE North of Scotland Hydro-Electric Board's annual report for 1959 shows that the Board last year increased the capacity of its hydro-electric stations to 866MW, generated 2196 million units of electricity, and connected 10,043 new consumers to the mains. There was a trading loss for the year of £29,170 which raised the accumulated deficit to £753,626, The report states that the year was characterised by an unusually dry summer which made it necessary to run down storage and use additional thermal power except in the last two months of the year.

No new scheme was promoted in 1959 but of those under survey, Nevis and Laidon have nearly reached that stage. At present 582MW of hydro-electric power is under construction and a further 555MW under survey, the corresponding figures for average annual output being 911 million and 1718 million kilowatt hours. During the year over 53MW of new plant was brought into operation. Total capital expenditure during 1959 amounted to £12,996,663 and the Board's aggregate capital expenditure to the end of the year was £205,298,000, of which £141,376,000 was for hydro-electric schemes.

The Awe project was authorised last May, at an estimated cost of £24,500,000. It is programmed for completion in 1966. Work began on this project as well as on the Strathfarrar and Kilmorack project at an estimated cost of £14,250,000. The estimated completion date for this project is 1964. Work also began on the Loch Glashan project at an estimated cost of £1,300,000. These works are expected to be completed in 1962.

In Upper Glen Nevis the exploratory borings to investigate the foundation conditions at possible dam sites were completed. The conditions favour a dam, of arch design, at the upper end of the gorge. The Board is now preparing a constructional scheme to develop the difference of 900ft between the impounding level at this site and that of Loch Leven. Similar investigations of the foundation conditions at the outlet of Loch Laidon have also given satisfactory results and a scheme is now being considered to develop this loch as a storage reservoir and at the same time to use the difference in level between Loch Laidon and Loch Eigheach for the generation of electricity. If Loch Laidon becomes a storage reservoir, unregulated water which now comes from the Moor of Rannoch (catchment area 48 square miles) and which contributes to the flow to power stations lower down the River Tummel, would become controlled and lead to more efficient running of all the stations in the Tummel Valley group. Surveys continued at a number of other possible schemes.

The Board is still considering the possibility of bringing a nuclear station into use in the late 1960s.

As all the indications were that reliable commercial operation was unlikely, the project for the gas turbine at Dundee power station has been discontinued, by agreement with the contractor.

Test runs continued, however, with the Altnabreac peat-fired gas turbine but, because of vibration, certain modifications, including the fitting of an additional alternator bearing, were put in hand. Since then a number of trial runs have been completed and modifications are still being made. During the year the plant ran 1017 hours. It produced 301,000 units and burned 433 tons of peat. The total number of hours which the plant has run since it was first started in June, 1958, is 1456.

Iron and Steel Institute

A MEETING of the Iron and Steel Engineers Group is to be held at 4, Grosvenor Gardens, London, S.W.1, on Wednesday and Thursday, April 6 and 7, the sessions beginning at 10.30 a.m. and 2.30 p.m. each day. The meeting will be devoted to the discussion of four papers dealing with the design and operation of heavy plate mills and their auxiliary equipment.

The annual general meeting of the Iron and Steel Institute is to take place on Tuesday, Wednesday and Thursday, May 3, 4 and 5. The first day's sessions are at the Royal Commonwealth Society, Northumberland Avenue, London, W.C.2, beginning at 10.30 a.m. with the formal business, following which Mr. W. F. Cartwright will be installed as president and will deliver his address. In the afternoon, at 2.30 p.m., the first two papers in a symposium on "Wide Strip Production" will be discussed. This symposium is to be continued on the two following days, May 4 and 5, in the Great Hall, Caxton Hall, London, S.W.1, beginning each day at 10 a.m. In addition, on the final day of the meeting, May 5, there is to be a session, at 10.30 a.m., in Convocation Hall, Church House, Great Smith Street, London, S.W.1, to discuss "Steelmaking in Electric Arc Furnaces." The Institute's dinner will be held at Grosvenor House, Park Lane, London, W.1, on Wednesday, May 4, at 7 for 7.30 p.m.

Research Reactors Division, Harwell

A NEW division, to be known as the Research Reactors Division, has been formed at Harwell. It will have responsibility for the operation, maintenance, safety and development of Harwell research reactors and their facilities, including rigs, loops and auxiliary equipment. It will also undertake physics experiments necessary for the solution of design and operational problems and studies on possible future research reactor systems.

The division has been formed from the research reactor group of the former Reactor Division, now mostly transferred to the Atomic Energy Establishment, Winfrith, and the reactor services group, previously part of the Engineering Division. Senior posts in the new division will be open to both scientists and engineers with the positions of Division Head and Deputy Division Head normally held one by a scientist and the other by an engineer. In addition, scientists will be encouraged to enter the Operations Group of the Division and will be eligible for posts as chief pile operators.

The Research Reactor Division will be responsible for the reactors, "Dido," "Pluto," "Lido," "Bepo," "Gleep," and for operation only of "Dimple." Mr. W. F. Wood has been appointed Acting Division Head.

"Herald" Research Reactor

A NEW research reactor, known as "Herald," of the United Kingdom Atomic Energy Authority, went critical last week. "Herald" is installed at the Atomic Weapons Research Establishment, Aldermaston, where it will be used for nuclear research work requiring intense neutron beams, and for irradiation damage studies on reactor materials.

"Herald" is a development of the "Merlin" reactor at the fundamental research laboratories of Associated Electrical Industries, Ltd., Aldermaston. Light water is the moderator and coolant. The core is a rectangular structure measuring about 21in by 12in, by 24in high, and can be moved vertically into any one of three fixed positions. The fuel elements consist of assemblies of thin plates of enriched uranium-aluminium alloy. With a core loading of about 10 lb ^{235}U the reactor has a continuous thermal rating of 5MW.

Shielding, by thicknesses of iron-shot concrete and barytes concrete, is in the form of an irregular polygon with a maximum plan dimension of about 23ft and height 30ft. Between the concrete and the cylindrical tank there is a thermal shield of lead 4in thick.

A high flux density of thermal and fast neutrons, of the order of 10^{14} neutrons per square centimetre is expected. The research facilities include four 6in horizontal beam tubes; and a thermal column 48in by 48in, pierced by (*a*) a lateral beam tube 6in diameter, (*b*) a radial beam tube 8in by 8in, and (*c*) a lateral through tube 6in diameter.

The reactor was built for the United Kingdom Atomic Energy Authority by the A.E.I.–John Thompson Nuclear Energy Company, Ltd.; construction was started in 1958.

SHORTER REPORTS *(Continued)*

Vehicle-Actuated Traffic Signals

AT a meeting of the Institution of Highway Engineers on March 4 a paper entitled " Recent Developments in Vehicle-Actuated Traffic Signal Control " was presented by Mr. E. Thorpe, of the Automatic Telephone and Electric Company, Ltd. The author dealt first with improvements in the flexibility of controllers operating individually, and then with schemes in which several such controllers at successive intersections are linked back to a master controller so that the latter can apply an over-riding control. His descriptions of specific equipment related to the A.T. and E. " Electro-matic " system.

The first working unit of a more flexible controller, developed in co-operation with the Ministry of Transport to cover the widening margin between light and heavy traffic conditions, was installed in Liverpool just over two years ago. One of its facilities was a variable minimum green period. If only one vehicle was waiting at a traffic signal, it was given a minimum green of eight or ten seconds as preset for its particular phase. If the waiting vehicles increased in number, the minimum green was progressively lengthened up to a top limit of fifteen seconds. The rate of increase could be arranged to follow a low or high rate, the number of lanes involved determining which rate was appropriate. Under operational conditions, this facility automatically reduced the minimum green when it was safe to do so and permitted quicker phase changes during light traffic periods.

Once the minimum green had started, every vehicle crossing a detector in the relevant approach established for itself an extension time in the accepted manner. In previous " Electromatic " systems this extension was preset at a fixed time setting suitable for the particular site conditions. In practice this arrangement operated very satisfactorily, but in some cases the control system tended to be a little sluggish under light, fast traffic conditions. This indicated a need to relate the extension time with the speed of the vehicle and the controller now provided for speed-timed extensions, the time being varied automatically to enable each vehicle to travel a preset distance at its determined speed. This distance depended on detector location and intersection width, but in general would be the distance from the detector to midway through the junction. Speed was assessed by the time taken for a vehicle wheel to travel the distance between the two treads of the detector. Extensions were individual and not additive and the associated timer was only reset to a new time if the next extension requested was for a period longer than the unexpired time from the previous extension. For example, if four seconds of the current extension remained to be timed off, a request for a two-second extension would be absorbed, but one for five seconds would reset the timer to five seconds.

The period of time between the end of the green period of one phase and the beginning of the green to the following phase was called the " intergreen." It included both amber and red/amber and possibly all-red. The amber and red/amber timings were fixed at three and two seconds respectively and the shortest intergreen available for a normal phase change was four seconds, the last second of the amber and the first second of the red/amber running concurrently. Thus, red signals showed to both halting and opening phases for one second.

The intergreen so far described represented a fixed clearance period, its preset timing being unaffected by traffic conditions. It was termed " minimum intergreen " and in practice would be set to provide adequate clearance time to cover fluid traffic conditions. However, under heavy traffic conditions a longer clearance period might be necessary for such purposes as clearing out " right-turners " who had been forced to wait in the centre of the intersection. Such conditions were catered for by provision of a variable period which was inserted into the minimum intergreen as an all-red.

If a phase change took place due to a maximum termination or immediately at the end of a vehicle extension, the whole of the variable content of the intergreen (as preset) was inserted. If the change took place one second after the end of an extension, the variable content was automatically reduced by one second. If two seconds elapsed before the change, the all-red was reduced by two seconds and so on up to complete suppression.

Probably the most interesting and perhaps topical form of application was co-ordinated control involving the interlinking of two or more intersections. Such interest was not surprising in view of the extreme congestion during peak periods in most city centres. A simple case might concern a pedestrian crossing situated in an arm of a signalled junction and near enough to affect adversely traffic movement at the main junction. The pedestrian crossing could be separately signalled in such a manner that although push-button operated, the crossing period could only appear at a time which did not inconvenience the nearby junction. Another form of simple case might involve two signalled intersections fairly close together where it was desirable that the main road phase should be held by both intersections at the same time. In this case, the controllers could be arranged to forward a demand for the main phase to prepare the way and also be interlocked so that the maximum green periods ran concurrently.

For larger numbers of intersections, including pedestrian crossings if necessary, a full " Electromatic " bias system including a master timer could provide the necessary progressive facilities. The master timer determined the cycle time of the system and via the linking lines influenced the phases at each intersection in such a way that their appearances were related to a common synchronising point in the time cycle. Thus, the main road phases could be made to appear in a definite sequence through the series of intersections, the time spacing being such that a vehicle travelling at a speed for which the system was set up had an uninterrupted journey. The speed of the system could be varied by alteration of the time spacings or " offsets " and the number of vehicles allowed to pass through on each " wave " could be controlled by varying the cycle time or the portion allotted to the main phase.

Three plans of operation were available in the standard master, selection being either manual or by automatic preset time programme. Other forms of automatic selection based on vehicle density recorded by vehicle detectors had also been used. Under very light traffic conditions, the individual local controllers operated more or less as free agents but the master was continually supervising and would bias the local by shortening other phases if necessary if the main phase was required to appear quickly in order to maintain progression. This form of co-ordinated control was not limited to a through route, but could also be applied to area control, although the size and/or complexity of the area might require more than one master controller.

Marine Engineers Annual Dinner

THE fifty-seventh annual dinner of the Institute of Marine Engineers was held on March 11 at Grosvenor House, London, with the President, Sir William Wallace, in the chair, and was attended by over 1200 members and their guests. In proposing the toast of " The Royal and Merchant Navies of the British Commonwealth," the Netherlands Ambassador, Baron Adolph Bentinck was reminiscent about the Dutch and British navies in the past and the present and felt sure that both countries opposed flag discrimination, which, he urged, was out of date. The Minister of Transport, Mr. Ernest Marples, who responded, and also proposed the toast of " The Institute of Marine Engineers," commented that a generation ago there were plenty of qualified engineers at sea, whereas to-day their numbers were few. He felt that, in some part, this was due to full employment, since under such conditions people were apt to choose the easy job. It was essential to have more engineers and it was equally essential that they must be rewarded adequately. The Minister briefly mentioned nuclear power developments and underlined that it was vitally important to have freedom in shipping if we were to play our part. He also expressed the need of the right spirit in the country and went on to say that adversity fashioned character and that problems were both stimulating and a challenge. The president replied and commented upon his visits to the sections of the Institute, both in this country and abroad, and concluded by an appeal for ministerial help in resolving the frustration of progress caused by the trade union problems such as demarcation.

Electronics Industry Council

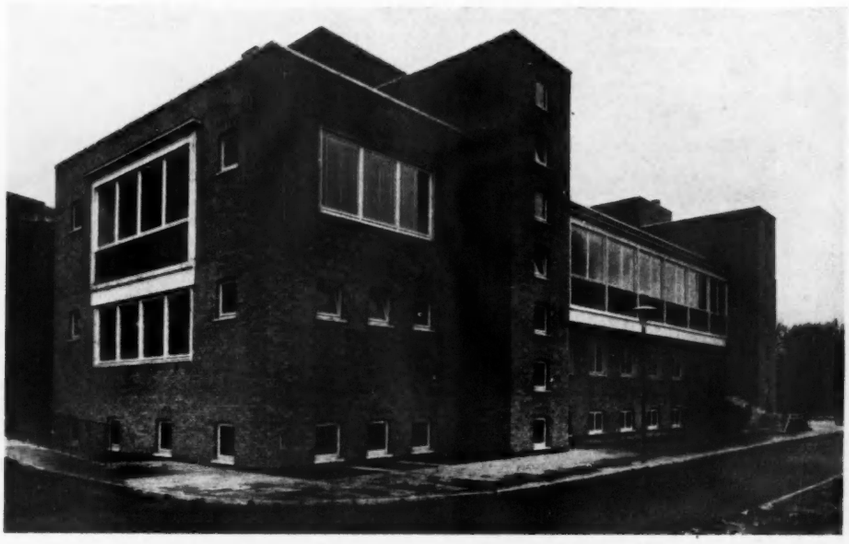
THE formation of an Electronics Industry Council is announced in London by the Electronic Engineering Association, who with the Radio and Electronic Component Manufacturers Federation and a number of other bodies has been discussing this for some time. The new council will be concerned with electronic instruments, sound and television transmitters, radio communication equipment, radar and radio navigational aids, computers, industrial electronic control equipment, and industrial television and the electronic components used therein.

The council's constitution will provide for the adherence of associations or federations of manufacturers concerned wholly or partly in the manufacture in the United Kingdom of electronic components, apparatus and equipment except for those used in the broadcast radio and television receiving industry and for public telephone services. Its objects are : to promote and further the well-being of the industry in the United Kingdom ; to provide a channel for communication with Her Majesty's Government ; and to co-operate with other industrial, commercial and mercantile bodies in the United Kingdom and abroad.

A main function of the new body will be to deal with matters of concern to the whole industry while its constituent bodies remain autonomous in their own fields of activity. Mr. L. T. Hinton, chairman of the Electronic Engineering Association, has explained that the new Council, being in the capital goods field, is complementary to the Radio Industry Council, which for more than a year now has been dealing only with the associations whose members make broadcasting receivers, or the components and valves for them. The offices of the Electronics Industry Council are at 11, Green Street, London, W.1.

James Clayton Prize

THE James Clayton prize is awarded annually by the Institution of Mechanical Engineers to a member or members who are adjudged to have contributed most in the year to modern engineering science " by way of research, invention, experimental work or a treatise or paper on a modern engineering subject, or originality in engineering design or by service to engineering." The 1959 award has been made jointly to Mr. C. B. Dicksee and Professor G. F. Mucklow. The citation to Mr. Dicksee praises his pioneering and subsequent development and research work on the high-speed compression-ignition engine, by which, it is stated, " he has become recognised throughout the world as an outstanding authority in this field." The award to Professor Mucklow is made " for continuous research and experimental work into the propagation of pulses (wave action) in gases, and problems connected with the internal combustion engine, and for his contributions to knowledge in that field of mechanical engineering."



British Railways research laboratory, Muswell Hill

Railway Research Laboratory

As part of the reorganisation of British Railways' Research a new laboratory has recently been built on the site of the former Alexandra Palace railway station at Muswell Hill, London. This reorganisation is intended to provide the railways with a modern and economical research service which can also be directed to assist other undertakings of the British Transport Commission. The new building, which we illustrate, marks the first stage in the scheme and was formally opened on March 11 by Sir Brian Robertson. The Commission took over about a dozen chemical laboratories, the activities of which have been co-ordinated since 1951. However, since many were unsuited for modern requirements and since expensive equipment needs to have maximum usage to be economic, the decision was made to concentrate the chemical services in a limited number of laboratories. The first of these is the building, just opened at Muswell Hill, which houses the headquarters staff of the chemical services, the London area chemical laboratory, the building materials laboratory and corrosion laboratory which were originally located at Euston, Stonebridge Park, Wimbledon and Derby respectively. The area served by the new laboratory is bounded by Sheerness, Aldershot, Reading, Oxford, Leamington, Rugby, Peterborough and the Wash. Among the work undertaken is the routine testing of materials, investigation into causes of damage to goods in transit, the examination of water supplies, fuel and food, the control of a variety of chemical manufacturing processes and any associated research problem which may arise.

Of brick-faced reinforced concrete construction, the building has three storeys, including a semi-basement while the roof is flat to facilitate the weathering tests on materials. Most of the floors are covered with P.V.C. "Crestaline," or acid-resisting tiles, while the ceilings are soundproof, and the laboratories in addition are flame-resisting. All the services are distributed by two vertical ducts which are connected by a horizontal duct under the basement floor and under the first floor by a false floor which allows for flexibility in siting benches. Two automatically controlled oil-fired boilers provide the necessary hot water for heating and other services while an automatically controlled compressor provides compressed air. There is a high frequency radio communication system for the location of staff.

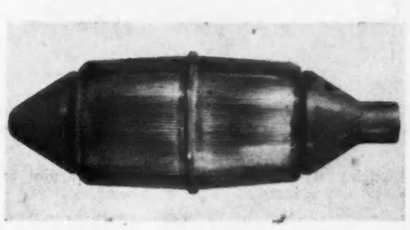
In the semi-basement is a corrosion laboratory for carrying out investigations, on a large scale, of metallic corrosion in structures and equipment exposed to severe conditions, so that advice may be given on the use of methods and materials and in design. Building materials are also studied, there being equipment for mixing concrete and mortars under controlled conditions and for curing at controlled temperature and humidity. The requisite humidity is provided by a curtain of water, at a thermostatically controlled temperature, flowing down expanded-aluminium sheets on three of the walls. Concrete specimens are also cured under water and all pass through the testing laboratory. Physical properties are established in a room on the ground floor which is equipped with a 200-ton and a 56-ton compression machine, a 2-ton tensometer and a bend test machine.

Most of the laboratories are placed on the first floor and are linked by a series of double swing doors. One laboratory is concerned with general analytical control, another deals with corrosion problems, such as in the cooling systems of diesel engines, where the comparative efficiencies of inhibitors in relation to a variety of metals have to be studied. Damage to goods and methods of packaging are checked and there is also a water laboratory for chemical and bacteriological examination and control of water supplies. Oils, particularly sump oils, are checked in a direct reading spectrograph for traces of metals and any sudden increase in metal content noted so that damage to or breakdown of diesel engines may be prevented.

Dr. F. F. C. Curtis, Architect to the British Transport Commission, was responsible for the building, the consulting structural engineer was Mr. A. E. Beer, the consulting services engineers were Messrs. F. C. Foreman and Partners, the quantity surveyors were Messrs. Newberry and Wyatt, and the contractor Holliday and Greenwood, Ltd.

Sealed Sodium Lantern

A HERMETICALLY-SEALED refractor assembly in the Siemens Ediswan "Orbit" lantern enables the unit to be used for lighting areas such as coal loading wharves and colliery sidings where dust exclusion is difficult with other methods of construction. The lantern is a product of the Lamps and Lighting Department, A.E.I. Radio and Electronic Components Division, 38-39, Upper Thames Street, London, E.C.4. In the "Orbit" design the lamp vacuum jacket forms part of a completely sealed system comprising the prismatic glassware, a small internal vitreous-enamelled reflector, the jacket, and the two end spinnings. This assembly is held together by three fixing rods, one of which is hollow to carry the cable to the lampholder.



Lantern for 140W sodium lamps. A hermetically-sealed refractor system incorporates the lamp vacuum jacket

Referring to the illustration, the aluminium alloy casting at the right of the lantern can be rotated on the supporting column for even light distribution on hills, adjustments being made to conform with three end slot markings for different gradients. The power supply cable is connected to a terminal block inside the casting, and internal wiring runs from the block, through the hollow fixing tube, to the lampholder at the other end of the lantern, enclosed by the conical quick-release cover on the left. With the 140W size of sodium lamps used in this lantern, the "U"-tube in which the discharge takes place is not integral with the outer vacuum jacket and can be renewed separately as necessary, the jacket remaining a permanent part of the lantern. There is, therefore, no need for further dismantling of the lantern than removal of the end casting on installation, and of the quick-release end cover for relamping. The smooth outer surface of the glassware simplifies external cleaning.

Light distribution is controlled by "Holophane" 4160 refractors, which in conjunction with the internal reflector above the lamp give a medium-angle distribution. Control gear is mounted remotely from the lantern. The dimensions of the "Orbit" are: diameter 11¾in, and length 30in, and the weight is 30 lb. For ordinary street lighting the lantern meets the requirements of Group A roads at 25ft mounting height and a spacing of 120ft to 150ft.

[Reply Card No. E4792]

Split Mechanical Seal

A SPLIT mechanical seal introduced by Flexibox, Ltd., Nash Road, Trafford Park, Manchester, 17, incorporates in a rotary seal wearing parts which can be quickly replaced without need for stripping down a shaft. In this face-type mechanical seal the sealing action is obtained by intimate contact between the rubbing surfaces of a stationary and a rotating member on a shaft. The components subject to wear comprise a split rotary seal ring packing, a split rotary ring insert with a solid locating ring and a split stationary seal ring insert with a solid locating ring. When the split components are in position, they are held together in accurate alignment by the solid locating rings. A flexible "O" ring, designed to prevent leakage along the shaft, is also split for ease of replacement. The stationary assembly is held firmly in a seal plate bolted to the stuffing-box casing. This seal plate has a ring of set screws by which its relative position in respect to the stationary assembly can be adjusted. This design of split mechanical seal is stated to be adapted for pressures up to 100 lb per square inch and temperatures up to 300 deg. Fah.

[Reply Card No. E4793]

Thermocouple Wires

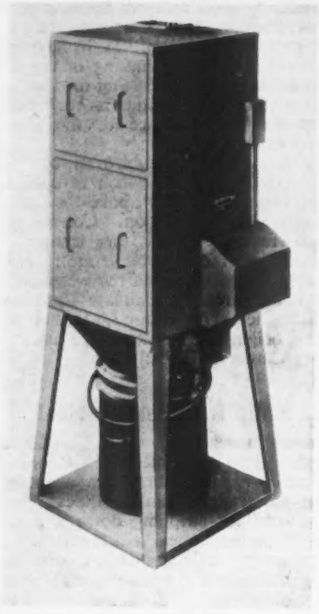
FOUR additions are announced to the range of Philips "Thermocoax" (miniature thermocouple) wire, distributed in the United Kingdom by Research and Control Instruments, Ltd., Instrument House, 207, King's Cross Road, London, W.C.1. They are as follows: 2BB Ac 10, two wires of alumel in a stainless steel sheath with an overall diameter of 1mm. This material can be used with two chromel-alumel junctions for measuring differential temperatures; 2AB Ac 15 and 2 AB Ac 20, chromel-alumel wires in a stainless steel sheath with overall diameters of 1·5mm and 2·0mm respectively; and 1 Nc I 05, a heating element of nichrome in an inconel sheath with an overall diameter of 0·5mm. "Thermocoax" wire has been designed for measuring a wide range of temperatures under extreme conditions, such as surface and working temperatures of all kinds of heat-treated materials of furnaces, working machine parts, and heating and cooling installations.

[Reply Card No. E4794]

SHORTER REPORTS *(Continued)*

Self-Contained Dust Collector

AN improved design of self-contained dust collector known as the " Unimaster " has been developed by Dallow Lambert and Co., Ltd., Thurmaston, Leicester, to succeed the existing range of " Dustmaster " units. This new design is stated to be more compact, incorporate a more efficient fan, be more easily cleaned and to have an improved filter element which is available in a variety of materials to suit particular applications. The general arrangement of the " Unimaster " can be seen in our illustration, and initially it is being made with a



Dust collector with a 70 sq ft filter cloth and a fan capacity range from 0 c.f.m. at 6·2in w.g. to 765 c.f.m. at 3·3in w.g.

filter cloth area of 70 square feet with a fan capacity range up to 765 cubic feet per minute at 3·3in water gauge.

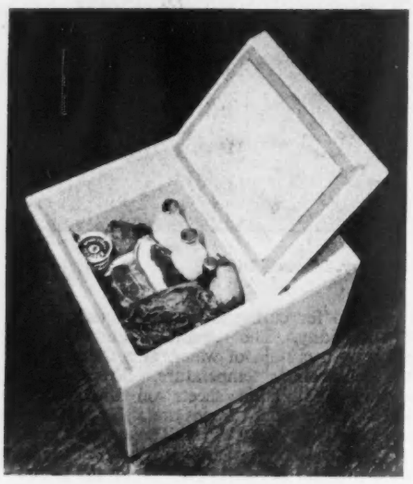
The filter element is easily removed for inspection and consists of individual pads or envelopes mounted in a common frame which is sealed from the fan chamber. The assembly is self-locating and can be removed by disconnecting a link connecting the filter mattress to the shaking mechanism, and releasing four nuts. The element is then free to slide out of the case. The filter cleaning mechanism, of a new motorised design, is operated by a $\frac{1}{3}$ h.p. electric motor which transmits an oscillating movement to the inserts within the filter pads or envelopes through an eccentric. These inserts consist of a flexible rustproof mesh mounted within a rigid frame and the oscillating movement causes the mesh to move rapidly backwards and forwards and induce an air current in a reverse direction through the filter fabric. This air current, allied with the oscillatory movement of the filter pads or envelopes, quickly removes the accumulated dust on the filter fabric. The cleaning mechanism is operated so long as a button is kept depressed, or the cleaning operation can be carried out automatically on a preset cycle which comes into effect when the fan motor stop button is depressed.

The dust container, available in two sizes of 2 cubic feet and 4 cubic feet capacity, is sealed to the unit by a quick release mechanism. By the fitting of an over-centre cam operating device the sealing gear handle when raised remains in the release position. The dust bin can then be removed, emptied and replaced.

[Reply Card No. E4801]

Thermoelectric Cold Box

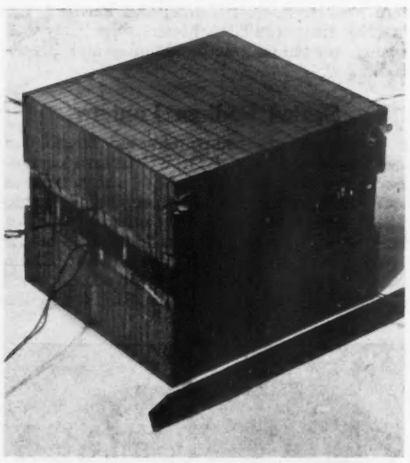
WORK on thermoelectric cooling carried out at its Wembley Research Laboratories has reached the stage at which The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, is able to announce a thermoelectric cold box, illustrated herewith, which is



Cold box incorporating semiconductor thermocouple assembly for cooling by the Peltier effect

claimed to be the first prototype design in the world for a commercial cold box of this description. The cooling element consists of a block of 182 thermocouples arranged as shown in the second illustration, and connected electrically in series. In the prototype the junctions are formed of p-type and n-type bismuth telluride, but investigation of other materials is continuing with the object of reducing current consumption. The prototype box is of about 1 cubic foot volume and could be carried in the boot of a car. It operates direct from a battery supply. Each thermocouple produces a cooling power of about $\frac{1}{4}$W at 5-10A. The drop of air temperature obtainable in an enclosure with the block illustrated is 20 deg. to 30 deg. Cent.

It is stated that the Peltier effect used here for cooling has already been applied to cooling the



Assembly of 182 semiconductor thermocouples as installed in the cold box

lead sulphide detector cells in the infra-red sensing devices of air-to-air missiles. Development of the principle for practical applications has been based on the availability in recent years of semiconductors for forming the thermocouples, in which the thermal electromotive force coefficient may rise to millivolts per deg. Cent. instead of units or tens of microvolts per deg. Cent. for metals. Constructional methods to provide adequate thermal isolation between the hot and cold sides of a junction have also had to be developed in order that the Peltier effect might have commercial application. An article on thermoelectric cooling using these principles appeared in our December 4, 1959, issue, page 734.

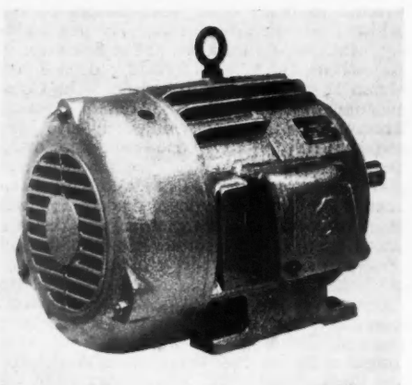
[Reply Card No. E4802]

Totally-Enclosed Fan-Cooled Motors

A NEW range of totally-enclosed fan-cooled electric motors, which comply with B.S. Draft Specification A (ELE) 1629, and are dimensionally interchangeable with British Standard ventilated motors made to B.S.2960, is being introduced by Higgs Motors, Ltd., Witton, Birmingham, 6.

These motors are designed to comply with B.S.2613 for class-E insulation (temperature rise not exceeding 65 deg. Cent.). As would be expected they are smaller and lighter than the corresponding totally-enclosed fan-cooled motor built to B.S.2083 and they cost less. The rotors are dynamically balanced and the enclosure provides protection in dirty atmospheres.

The foot-mounted range (an example of which is illustrated here) has been developed up to



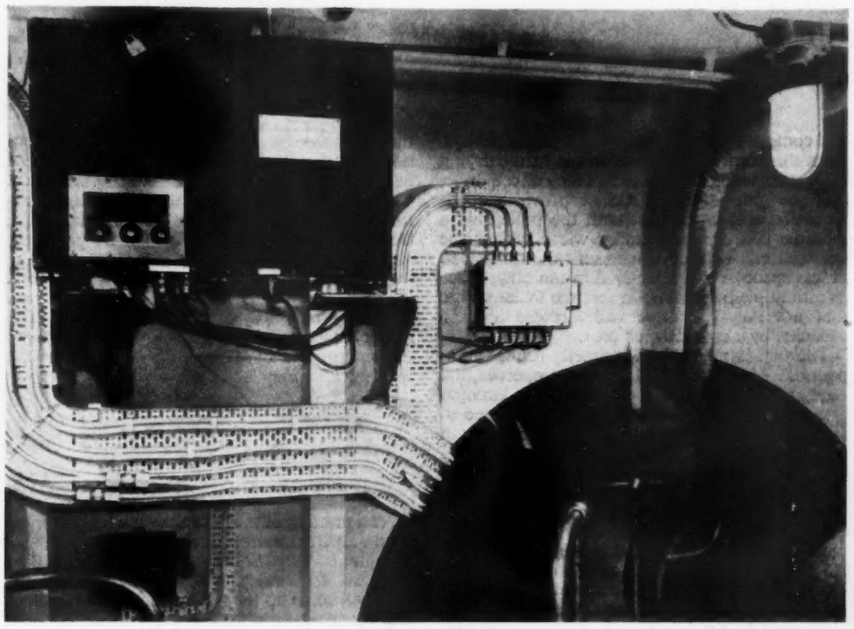
Totally-enclosed fan-cooled motor, with class-E insulation, to B.S.2613, temperature rise 65 deg. Cent

$7\frac{1}{2}$ h.p. at 1500 r.p.m., but the maker anticipates that machines with ratings up to 40 h.p. will be available in the near future. Other derivatives, such as flange-mounted and totally-enclosed non-ventilated motors, are to be added to the range later. With the exception of the smallest frame size (rated at $1\frac{1}{2}$ h.p. at 3000 r.p.m., for example) the stator housing is ribbed externally to give added strength to the shell and increased surface area for cooling.

[Reply Card No. E4803]

Mission to Argentina

RECENTLY, the Executive Committee of the Council of British Manufacturers of Petroleum Equipment announced that a mission had been formed to visit Argentina. The members are : Mr. E. F. E. Howard, Hayward Tyler and Co., Ltd. ; Mr. L. S. Dawson, Oil Well Engineering Company, Ltd. ; Mr. G. Goodrich, Stewarts and Lloyds, Ltd. ; and Mr. D. S. Barwell. The terms of reference of the mission, which will assemble in Buenos Aires on March 20 and remain until the end of the month, are : to acquaint the Government controlled oil companies in the Argentine and Chile with the potential of the British petroleum equipment industry, and to discuss the possibilities of extended credit facilities with particular reference to the packaged deal.



Integrating power meter shown mounted in "Antenor"

Integrating Power Meter

To meet the need for the accurate measurement of the power developed by the main propulsion machinery, Pametrada developed a power meter which counts up and displays in readable form the total number of horsepower hours generated by the machinery of a ship. The first of these units, as reported in the 1957 Pametrada Progress Report, was installed on board the diesel-engined Holt cargo liner M.V. "Antenor" in July, 1957, while a second was fitted later in the Shell tanker "Auris." The instrument is now manufactured commercially by Muirhead and Co., Ltd., Beckenham, Kent, and the Muirhead-Pametrada integrating power meter is designed for accurately measuring powers of 2000 h.p. and above. As noted above, it is not simply a torque-measurer since it continuously multiplies the revolutions per minute by the torque transmitted by the propeller shaft to indicate the total number of horsepower hours delivered. Thus at any time efficiency checks can be made by comparing energy expended against fuel consumed; furthermore, performance between successive voyages or between similar ships can be compared. The use of the meters also enables the power output of each shaft of a multi-shaft installation to be readily equalised.

From the diagram it will be seen that the

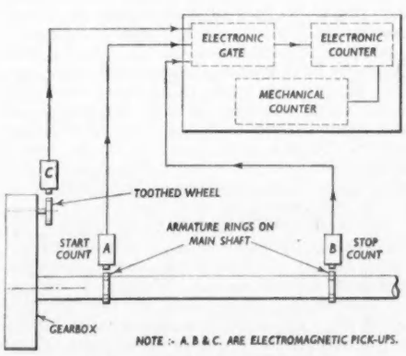


Diagram of power meter system

torque in the main shaft is measured by two electro-magnetic pick-ups which are arranged so that their signals are simultaneous, when the shaft is turning without load, but with increase in torque lag, one behind the other, by an angle directly proportional to the torque. Both signals are fed into the instrument to open and close an electronic gate. The related shaft armature rings are of steel and contain a number of armatures. A third pick-up, built into a gearbox with a gear ratio, arranged to rotate a toothed wheel at about 1000 r.p.m., generates a high frequency signal, the frequency being directly proportional to the shaft revolutions per minute, which is fed into the instrument where the number of high frequency peaks during each period that the gate is open is counted. The total count in a given period is proportional to the shaft torque multiplied by the revolutions to give shaft horsepower hours. These are displayed numerically on the face of the meter.

The electronic unit, illustrated herewith, consists of a sealed steel box which contains pulse shaping and electronic gate circuits and a three-decade Dekatron counter unit to reduce the input frequency to within the operating range of a five-decade mechanical counter having an overall storage capacity of 6400 million high frequency counts which can be arranged to represent, say, fifty days at full power. The instrument is designed for a power supply of 230V, 50 c/s.

[Reply Card No. E4811]

Weighing Equipment for Aerial Ropeway Skips

An intermittent gross weigher has been developed by Adequate Weighers, Ltd., Bridge Road, Sutton, Surrey, to provide for the fully-automatic recording of the weight of material carried over an aerial ropeway system. The machine comprises a lever system with a pendulum resistant, a pendulum clamping device and the maker's "Adequate Integrator" incorporating a special gear mechanism to isolate the totaliser when required.

In the sequence of operation a skip carriage moves on to a section of weigh rail, which is suspended from two tubular levers. The load applied to the weigh rail is transmitted by the two power arms to a further single lever projecting at right angles. This lever through a connecting rod transfers the load to a lever system incorporated with the recording mechanism, which is normally situated at ground level as shown in our illustration. The resultant force of this final lever system is applied to the pendulum resistant of the mechanism. The pendulum carries a fork which controls the lateral movement of a steel ball drive in the integrating mechanism.

As soon as a skip is fully on the weigh rail, it trips a switch which first releases the clamping mechanism on the pendulum and allows the pendulum to adjust itself to the weight of the skip, and then starts a time relay mechanism. Before the skip moves off the weigh rail, the time relay operates the clamping mechanism to hold the pendulum at the position indicating the weight of the skip. A fraction of a second later, the relay starts the recording cycle. A gear mechanism engages the totaliser with the continually running integrating mechanism of the equipment for the precise period of time required to record the weight of the skip. Although the gear mechanism disengages the totaliser as soon as the weight is registered, the pendulum resistant remains held firm at the position indicated by the last weight until the next skip arrives and releases the mechanism. The lever system has thus only to adjust itself to the change in weight of successive skips and does not have to move from zero to load each time.

Although this is primarily a gross weighing equipment, the mechanism can be arranged to allow for the tare of empty skips. It is, however, a major problem to tare all skips to the same weight and ensure clean discharge, and it

Recording equipment of an aerial ropeway skip weighing installation

is recommended that for maximum accuracy two weighers be installed, one situated before and the other after the loading point.

[Reply Card No. E4812]

Society of Glass Technology Journals

It is forty-three years since the first number of the *Journal of the Society of Glass Technology* was published, and during the intervening years the number of problems being investigated in the physics and chemistry of glasses have greatly increased. At present the results of many of the laboratory investigations are published in a wide variety of journals, so that the Society embarked on a new publication policy to provide a vehicle for such publications. As a result of this decision the Society's journal is now being published in two parts, one being named *Glass Technology* and the other *Physics and Chemistry of Glasses*, and the first number of each has just been published. *Glass Technology* will contain reports of applied science and of important developments in the glass industry in addition to news of the Society, while *Physics and Chemistry in Glasses* will be concerned with detailed reports of theoretical and experimental studies of glasses. Both journals, which are published bi-monthly, are issued free to members and may be obtained by non-members at 25s. per issue or £6 15s. per volume or for a joint annual subscription of £10.

SHORTER REPORTS *(Continued)*

Rotary Discharge Valve

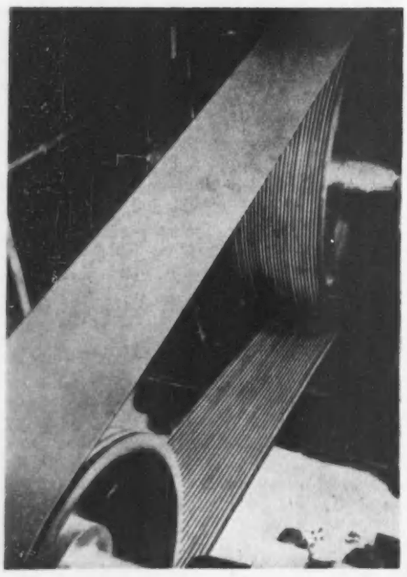
A ROTARY discharge valve to permit continuous and free discharge of dust or fine powders from hoppers or bin outlets is now made by Dunford and Elliott Process Engineering, Ltd., Linford Street, London, S.W.8, in two sizes. This valve has a horizontal body with 8in square inlet and outlet flanges between which a 9in diameter, four-bladed rotor revolves on a longitudinal axis. The rotor is shrouded and a positive seal is provided between its ends and the housing by renewable hard felt seals recessed into the main body casting. Gas and dust tightness is ensured by the fitting of adjustable stainless steel neoprene or rubber sealing and wearing strips to the tips of the rotor blades.

The rotor is carried on the drive shaft of a reduction gear built into the body end cover, the drive being transmitted through a shear pin to prevent damage to the gearbox or the motor in the event of overloading or jamming of the rotor. A ¼ b.h.p. totally-enclosed, fan-cooled, continuously rated squirrel cage motor, driving through the triple-reduction gearbox, provides a rotor speed of 12 r.p.m. The valves are manufactured in cast iron or stainless steel and are available in single unit form, having a capacity of 100 cubic feet per hour, or as duplex units with double this capacity.

[Reply Card No. E4821]

Belt Drives

THE Turner Brothers Asbestos Company, Ltd., of Rochdale, has now acquired a licence for the manufacture and sale in this country of the " Poly-V " belt drive developed by Raybestos-Manhattan Inc., of the United States. This



Single 9in wide section " Poly-V " belt replaces ten " D " section vee-belts on a diesel alternator drive, saving 40 per cent in pulley width

form of belt power transmission is claimed to incorporate the best features of vee-belt and flat belt drives, by combining the flexibility and simplicity of a flat belt drive with the higher speed ratios, shorter centre distances and freedom from slip of the vee-belt drive.

The " Poly-V " belt, as can be seen in the diagram reproduced herewith, consists essentially of a flat belt on the inner surface of which is moulded a series of parallel vee-shaped ribs. The ribs form the driving surface of the belt and completely fill mating grooves on the pulleys. With this form of construction the load carrying member extends across the full face of the drive, and the grooved inner surface provides about twice the area in contact with the pulleys as a multiple belt drive of similar width. Thus the new belt can be used to transmit the same load in less space or a greater load in the same space as a multiple belt drive ; in fact the makers state that a " Poly-V " drive will increase a drive capacity by about 50 per cent.

The belt is made from synthetic rubber compounds to give heat and oil resisting properties, and the high tenacity synthetic cords impart strength and resilience to shock. The cords are treated to secure the maximum amount of adhesion with the body of the belt, and the base rubber used is softer than normally employed in vee-belt constructions. This softness allows the rubber to completely fill the pulley grooves and exerts an even pressure all over the rib face, thereby securing uniform belt and pulley wear. The rib faces are covered with cloths, or in the case of the smallest belts with special compounds containing a high proportion of fibre.

These belts are being made in three sizes with rib widths of $^{3}/_{32}$in, $^{1}/_{8}$in and $^{3}/_{16}$in respectively and the rib angle is 40 deg. in each case.

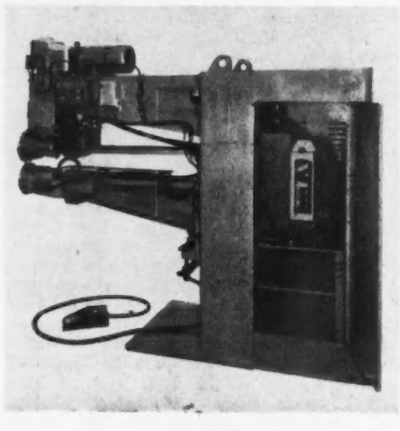
[Reply Card No. E4822]

Roll Seam Welding Machine

WE illustrate a universal roll seam welding machine developed by Electro Mechan-Heat, Ltd., Kingston upon Thames, for the production of drums, tanks, and other sheet metal work. The machine has a heavy cabinet body within which are housed the transformer and ancillary equipment. The upper arm is rigidly fixed to the front of the body and the lower arm of high tensile copper alloy is bolted to a tee-slotted pad across which it can be adjusted for lining up the electrodes. This lower arm is also adjustable for height in the frame to compensate for electrode wear.

The upper electrode is driven by a three-phase Kopp variable speed motor developing 0·5 h.p. at 1000 r.p.m., and can be rotated to give lineal feed rates between 1ft 11in and 21ft 6in per minute. This drive is transmitted through gearing and a vertical shaft passing through an air cylinder by the piston of which pressure is imparted to the electrode. The piston operates a ram giving a maximum travel of 1·97in and a maximum welding load of 1625 lb can be imposed between the electrodes. Five sizes of electrodes with diameters from 7in to 9in are available, and the electrode rollers are water-cooled.

The machine can be adjusted for circumferential or longitudinal seam welding by rotating



Universal seam welding machine

the head through 90 deg. and changing extensions on the lower arm. Initially the machine has been fitted with a single-phase a.c. 400/440V, stacked core, water-cooled, transformer and, if required, transformers for from 200V to 500V supplies can be provided. An eight-step tap-link panel is mounted on the transformer and power ratings, for a total working time of not more than four minutes, may vary between 50kVA and 160kVA. The maker states that transformers of different types and ratings in accordance with the length of the welding arm may be fitted.

[Reply Card No. E4823]

Short-Range Air Navigational Aids

AT a meeting of the council of the International Civil Air Organisation next month the proposal to adopt VOR/DMET as an international standard short-range navigational aid for aircraft will come up for ratification. This proposal was accepted by a special meeting of I.C.A.O. in Montreal in February, 1959. On that occasion the United Kingdom delegation withdrew its proposal for the adoption of Decca, as a protest because the choice of DMET had in its view been agreed without any comparison of it or the Decca system against operational requirements. This action was fully endorsed by the Minister of Transport and Civil Aviation in the House of Commons on March 4, 1959, when he said : " It is essential to the future of safe navigation in the air that I.C.A.O. should establish adequate technical criteria for defining navigational requirements and that a detailed examination should then be made of the extent to which either of the two systems meets those requirements. Neither of these things has been done."

The British case will again be pressed at the forthcoming I.C.A.O. council meeting with a view at least to deferring ratification of the Montreal meeting's proposal in order that further comparative studies may be made. In the meantime a report by the Federal Aviation Agency in the U.S.A. on the Decca system in aircraft has been the subject of comments published this month by the Decca Navigator Company, Ltd., relating to the report supplement dealing with Mark 10 Decca in a fixed-wing aircraft (the report proper is an evaluation of Mark 8 Decca in helicopters, and this was not commented upon because these trials were still in progress). The Decca document criticises the form of questions put to pilots engaged in the evaluation with fixed-wing aircraft, particularly with respect to lack of quantitative data, and also the conclusions drawn. It makes a plea for a side-by-side comparison of VOR/DMET with Decca by a competent independent authority. The flights were made using the New York Decca chain (opened in 1958 for evaluation with particular respect to helicopter operations) and the Decca comment on the F.A.A. report claims that analysis of the routes flown shows more than half to have been outside the basic service area of that chain.

The VOR/DMET system is an addition to the VOR (very high-frequency omnidirectional range) facility to show distance from the VOR beacon as well as bearing. DMET is the distance-measuring component of the TACAN military navigational aid. Range and bearing are shown on separate indicators, providing the information required for plotting fixes. A combined bearing and distance display may be provided for homing.

At the moment a presentation of position directly on a map, as in the Decca flight log, has not been finalised and is therefore not yet available for general civil use. The VOR/DMET service operates in the v.h.f. band and ground installations must make allowance for site errors which assume more importance than in the Decca low-frequency system.

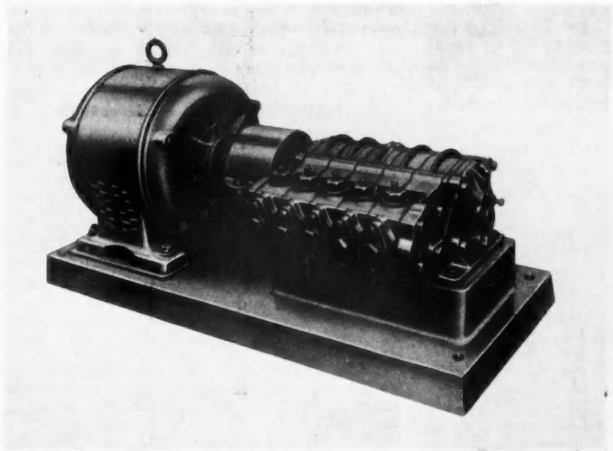
Multi-Cylinder High-Speed Hydraulic Pump

A DESIGN of high-speed hydraulic pump of unit construction and with from three to six cylinders has been produced by Joseph Evans and Sons (Wolverhampton), Ltd., for application where a high-pressure pump of very small capacity is required. A typical example of one of these pumps is shown in our illustration.

Each cylinder has an output of 0·6 imperial gallon per minute and a six-cylinder unit would thus have an output of 3·6 imperial gallons per minute. Delivery pressure is 1000 lb per square inch. The eccentric shaft of the pump, which is mounted on roller bearings, is coupled directly through a flexible coupling to the motor, which runs at a synchronous speed of 1000 r.p.m.

The pumps are suitable for operation with water, water/soluble oil mixture or hydraulic oil as the working medium and the design can be adapted for use with other liquids. The units can be provided with spring-loaded relief valves, or alternatively with automatic unloading valves, which enables them to run light when operating against closed stop valves.

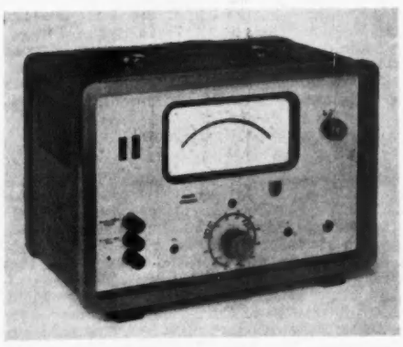
[Reply Card No. E4831]



High-speed hydraulic pump of unit construction with up to six cylinders, each of which has an output of 0·6 gallon per minute at 1000 lb per square inch

D.C. Microvoltmeter

THE twenty-two ranges of the GM6020 microvoltmeter illustrated cover full-scale deflections between 10μV and 1000V. This instrument is of Philips manufacture and is distributed in the United Kingdom by Research and Control Instruments, Ltd., Instrument House, 207, King's Cross Road, London, W.C.1. The d.c. voltage to be measured is applied through an attenuator and filter to a chopper which converts it into a square-wave for amplification in a four-stage a.c. amplifier, with a high degree of feed-back to ensure stability. A bridge rectifier provides a d.c. input for the moving coil meter.



Microvoltmeter with automatic polarity indication and built-in calibrating facility

Since the meter deflection is always positive, the polarity of the voltage being measured is shown automatically by two luminous columns. A calibration voltage of 3mV can be derived from the measuring-range attenuator for checking the meter. Zero-setting and calibration controls are both on the front panel, enabling adjustments to be made while the meter is connected to the circuit under test. The 5in linear scale has anti-parallax mirror reading. Measurement of v.h.f. voltages up to 800 Mc/s can be effected by using a GM6050 measuring probe.

The meter operates on all normal mains voltages with frequencies from 50 to 100 c/s, and consumes 32W. Protection against very high voltages in the maximum sensitivity position is provided by small neon tubes in the attenuator, and the power unit incorporates electronic stabilisation. The instrument can be used for measurement of direct currents from 10μμA to 10μA and for resistance measurements up to several million megohms, using an external d.c. source.

[Reply Card No. E4832]

Data Logging System

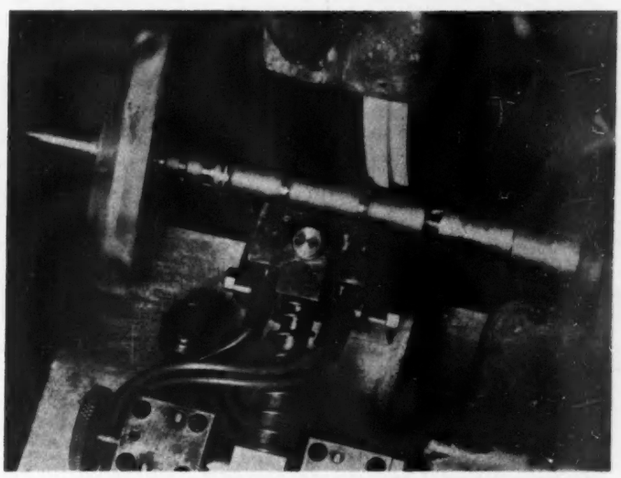
FOR presenting information on conditions at many different points in a large plant, E.M.I. Electronics, Ltd., Hayes, Middlesex, has introduced a range of "Emidata" high-speed digital data analysers. Input data may be derived, for example, from continuous scanning of a large number of transducers. This information is processed at high speed and re-presented in sorted histogram form. The analysers were developed originally in conjunction with the United Kingdom Atomic Energy Authority for high-speed automatic histogram analysis of very large quantities of statistical nuclear data. They use the "Emidec" 2400 range of standard logic units and "Emidata" magnetic tape decks. When input data occur at a slow mean rate, information may first be accumulated in unsorted form on magnetic tape, which is subsequently transferred to a centrally located analyser for high-speed sorting. The output of these analysers can be in graphical or tabular printed form, or as punched paper tape or punched card, directly suitable for further computation in a conventional digital computer.

[Reply Card No. E4833]

Valves for Airborne Radar

A NEW magnetron for airborne radar installations, capable of delivering a peak power output of 20kW, has been developed by The English Electric Valve Company, Ltd., Chelmsford, Essex. The magnetron is known as the M559 and is designed to operate at a fixed frequency in the range 9345–9405 Mc/s. Having a single packaged internal magnet, the magnetron is stated to be more compact than other units of comparable power rating. Maximum overall dimensions are 5·38in by 4·47in by 3·57in and it weighs 3¼ lb. Flying leads are fitted and the output waveguide is sealed with a vacuum-tight window, thus permitting operation at high altitudes without pressurising. The waveguide output flange is designed for coupling directly to waveguide No. 16 (0·900in by 0·400in internal dimensions). A further introduction announced by the same company is the K359 reflex klystron for use as a local oscillator in the frequency range 8050 kc/s to 8800 kc/s, and intended primarily for airborne installations. This valve, also, is constructed so that it can be used at high altitudes without pressurisation, and has direct coupling facilities to No. 16 waveguide.

[Reply Card No. E4834]



A valve spool in process of grinding. The spring-loaded shoe is seen bearing on the land shoulders of the spool and four air-lines lead off to the control dials

Visual Measurement During Precision Spool Grinding

AN essential feature of the electro-hydraulic servo valves used on machine and automatic control systems by the Sperry Gyroscope Company, Ltd., Great West Road, Brentford, Middlesex, is rapid response at pressures up to 3000 lb per square inch. This requirement calls for extremely accurate machining to ensure perfect mating of spool shoulders with cylinder liner ports, and, until recently, this accuracy was achieved by grinding each of the four "lands" as a separate operation, each operation calling for individual checks in the calibration fixture and subsequent regrinds until perfect matching was achieved. The time involved in attaining the very necessary accuracy was considerable, and to simplify and speed this work, the firm's Industrial Division devised an air-gauging system. The equipment used for this system, manufactured to Sperry designs by Thomas Mercer, Ltd., of St. Albans, shows the operator, on four large control dials, exactly how much metal is still to be removed from each land. With the new equipment all four lands on a spool's shoulders can now be ground to 0·0002in maximum tolerance without removing the valve from the machine illustrated above.

On the machine a "shoe" is placed over the spool valve so that it bears on the valve's shoulders opposite to the grinding wheel. Four holes drilled in the shoe are each connected by a pipe to an air pressure supply and each pipe has a sensitive, large-dial pressure gauge "teed" into it. The shoe holes are so arranged that when the exact amount of metal has been removed from the land, the air flow is de-restricted to a known degree causing a drop in pressure. The pressure gauges, calibrated in ten-thousandths of an inch, give a steadily decreasing reading as more metal is removed and indicate exactly when the job is down to size.

We are informed that this air-gauging system is to be applied in the future to accelerate the manufacture and increase the competitive quality of similar extremely accurate Sperry products.

[Reply Card No. E4835]

Anti-Fouling System for Underwater Structures

FOULING of ships' hulls by both plant and animal organisms has constantly engaged attention from the earliest times, and the traditional methods have included sheathing with copper and latterly the application of paints containing compounds of copper, arsenic or mercury. Temperature, salinity, depth and pollution of the water largely control the degree of fouling, the effect of which is to increase the frictional resistance of a ship by a considerable amount. This involves loss of speed with reduction in earnings or the use of increased power to maintain speed, resulting in increased fuel bills. A further effect of fouling organisms is the acceleration of corrosion due to local penetration of the anti-corrosive paint system.

At present the prevention of fouling is mainly by the application of anti-fouling paints having leaching rates, adequate to prevent the growth of marine organisms. Such paints have a life limited to the time taken to exhaust their toxic properties, and the effective time is only part of the life since the paint film liberates toxic constantly while immersed, irrespective of actual requirements. An attempt to solve the problem has been made by Charlton Weddle and Co., Ltd., Manor Works, Newcastle upon Tyne, with the development of its "Anfo" system. In this there are two basic elements, a toxin CW.60.B and a mechanically-controlled system for its dispersal over the underwater structure. This particular toxin, it is claimed, will destroy or deter all fouling organisms including bacteria and the method of its dispersal will result in a highly toxic film being built up on the underwater surface.

The "Anfo" unit, which is operated from a control panel, consists of a compressor, adjustable injector pump and atomising nozzle together with small bore high impact P.V.C. emission tubes that control the dispersal of the toxin. Also provided is a 500 gallons gravity feed tank to hold the CW.60.B solution and a carrying agent which is kerosene, a non-persistent oil having suitable chemical characteristics. The average consumption varies between 1 to 4 pints per hour. The compressor supplies air to the main distribution lines while the motor-driven injector pump, which is supplied from the gravity tank, delivers a regulated flow of the solution through the atomising nozzle so that it enters the distribution line in a vaporised state ready to combine with the air. The toxic vapour thus evolved passes through a manifold, above the tank top, from which it is distributed to four emission tubes outside the hull. Regulating nipples in these tubes ensure that the toxic vapour is dispersed evenly along the length of the hull. Emission from the tubes is in the form of bubbles and these disperse over the underwater hull, on the way to the surface of the water, collapse and deposit toxic which forms a film lethal to fouling organisms.

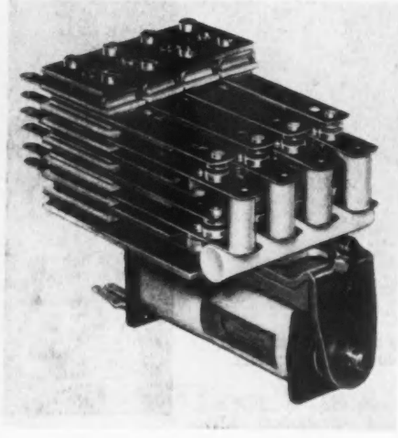
Since, apart from certain specific conditions already mentioned as influencing fouling, speed of flow of water is a critical factor, organisms being unable to attach themselves when the speed exceeds one knot, the "Anfo" system need only be operated during the period of a ship's stay in port, or when manœuvring or at anchor. The manufacturers suggest a routine in which the system is put into operation upon reaching the outer sea-buoy when inward bound and the reverse procedure at the same point when outward bound.

It is claimed for the new system that it maintains a clean hull so that performance is improved, fuel costs reduced, and dry docking for cleaning purposes is no longer necessary. The toxin CW.60.B is not dependent on external hull cathodic protection since it will adhere to the structure regardless of ionic attraction. Concurrent with the development of the system work has gone forward toward the formulation of the most suitable priming or rust inhibiting paints for use in conjunction with the "Anfo" system. The test data are available, and the company hopes to be able to recommend a priming paint specification.

[Reply Card No. E4841]

Heavy-Duty Relay

USING the same magnetic circuit, armature and coil as the standard Post Office 3000 relay, a new relay known as Series 7000 has been introduced by L. E. Simmonds, Ltd., 5, Byron Road, Harrow, Middlesex. This is intended to bridge the gap between the 3000 relay, which in its standard inter-service form has two heavy-duty changeover contacts capable of carrying a maximum of 8A non-inductive at 250V a.c., and industrial contactors. The company has previously supplied similar relays with four changeover contacts, incorporating its own design of buffer block, and now in the 7000 series has advanced the number to a maximum of eight, using the build-up shown in the illustration. The contacts are rated at 15A, 250V a.c., or 440V at 5A. All moving parts are of P.T.F.E. for maximum mechanical life. Relays having considerably higher working voltage characteristics can be made to meet customers' specifications. Light-duty spring sets can be fitted alongside the heavy-duty pattern as required, and the relays have full tropical finish as a standard feature. Their high shock-resisting qualities, inherent in the original 3000 relay design, have been demonstrated in a test in which the relays were mounted close to 4000A circuit breakers without disturbing their operation. The 7000 series has been approved by the Admiralty and given an Admiralty pattern number.



Eight heavy-duty changeover contacts operated by normal Post Office 3000 relay movement

[Reply Card No. E4842]

Chemical Plant in South Gloucestershire

THE intention to start work on the development of its 1000-acre site in South Gloucestershire was announced recently by Imperial Chemical Industries, Ltd. Initially ethylene oxide, ethylene glycol and associated products amounting to about 35,000 tons per year will be produced from ethylene supplied by Esso Petroleum Company, Ltd. The new phase of manufacture which is to take place in the company's Severnside site is an example of the flexibility of its tonnage organic chemical operations. It does not, however, represent a departure from the present naphtha-pyrolysis method of producing ethylene, but has been dictated by the need to expand production and the conditions obtaining. These stem from existing and estimated market trends for olefines and olefine derivatives, and the ability of Esso Petroleum Company, Ltd., to supply 40,000 tons of ethylene annually. To do this the oil company intends to expand its existing chemicals plant and to lay a pipeline, some 70 miles in length, from Fawley refinery to the Severnside site, to provide a direct supply of raw materials.

Although an integrated scheme on the Wilton pattern is not called for at the moment the company at present thinks that, when the demand for other olefines is established at Severnside and when the ethylene offtake is enough to support a large olefine plant, it may return to the naphtha-pyrolysis method of ethylene production. Such a step will naturally be governed by developments in the next decade. At Severnside Imperial Chemical Industries, Ltd., intends to operate the Scientific Design Company's process, which involves direct air oxidation of ethylene to ethylene oxide. This process differs from the alternative oxidation process in that air and not pure oxygen is used, and from the chlorhydrin process, in that chlorine is not employed. The company will design its own ethylene glycol plant and units for associated products.

Launches and Trial Trips

CHATHAM, refrigerated cargo ship; built by Alexander Stephen and Sons, Ltd., for Lamport and Holt Lines, Ltd.; length between perpendiculars 310ft, breadth moulded 47ft, depth to upper deck 26ft 6in, service speed 16 knots; four holds, two 10-ton and six 5-ton derricks, electric winches; Stephen-Sulzer single-acting, two-stroke turbocharged diesel engine, seven cylinders 580mm diameter by 760mm stroke, 5000 b.h.p. at 240 r.p.m. Launch, December 1.

MOUNTWOOD, passenger ferry; built by Philip and Son, Ltd., for Birkenhead Corporation; length between perpendiculars 142ft 6in, breadth moulded 39ft, depth moulded 12ft 6in, mean draught loaded 7ft 3in, trial speed 12½ knots; 1200 passengers on Steam 5 certificate, passenger accommodation on three decks; three 60kW diesel-driven generators; two Crossley H.R.N. eight-cylinder two-stroke diesel engines, each of 680 b.h.p. at 350 r.p.m. Trial, January.

DUKE OF MISTRA, cargo liner; built by the Furness Shipbuilding Company, Ltd., for the Trent Maritime Company, Ltd.; length between perpendiculars 480ft, breadth moulded 66ft, depth moulded to upper deck 42ft 6in, draught 31ft 4in, deadweight 16,010 tons; five holds, MacGregor steel hatch covers, one 30-ton, twelve 5-ton and two 3-ton derricks, electric winches; three 200kW diesel-driven generators; Hawthorn-Doxford five-cylinder, single-acting, two-stroke opposed piston oil engine, 5500 b.h.p. at 115 r.p.m. Trial, January 8.

BRITISH KIWI, oil tanker; built by Smith's Dock Company, Ltd., for the B.P. Tanker Company, Ltd.; length between perpendiculars 495ft, breadth moulded 69ft, depth moulded 37ft, deadweight 15,565 tons on 29ft 4½in summer draught; twenty-seven cargo tanks, two cargo pump rooms, four 500 tons per hour cargo pumps; two 250kW diesel-driven generators, one 75kW steam-driven set; Hawthorn-Doxford exhaust-turbo-charged, diaphragm, six-cylinder oil engine, 7200 service brake horsepower at 115 r.p.m. Trial, January.

REGENT FALCON, oil tanker; built by the Furness Shipbuilding Company, Ltd., for John L. Jacobs and Co., Ltd.; length between perpendiculars 525ft, breadth moulded 71ft, depth moulded 39ft 3in, draught 30ft 7½in, deadweight 18,025 tons; twenty-seven cargo oil tanks, one main cargo pump room, three turbine-driven 700 tons per hour vertical centrifugal pumps, two 150 tons per hour stripping pumps and one 200 tons per hour pump; one diesel-driven and two steam-driven 100kW generators; Wallsend-Doxford, six-cylinder, diaphragm oil engine arranged to burn heavy fuel, 6900 b.h.p. at 116 r.p.m. Trial, December 2.

ILORIN PALM, open shelter deck cargo liner; built at the Neptune Works of Swan, Hunter and Wigham Richardson, Ltd., for the Palm Line, Ltd.; length between perpendiculars 430ft, breadth moulded 62ft 6in, depth moulded to shelter deck 36ft 11in, deadweight 8950 tons on 25ft 1¼in maximum draught; five holds and deep tank, three bipod masts, one 50-ton, four 15-ton, two 10-ton and ten 5-ton derricks, sixteen electric winches, two 100 tons per hour oil cargo pumps; three 250kW diesel-driven generators; Swan, Hunter-Doxford, four-cylinder, diaphragm oil engine, 4500 b.h.p. at 118 r.p.m. Trial, January 8.

NAPOLEON, passenger liner; built by the Forges et Chantiers de la Mediterranee-la Seyne for the Compagnie Generale Transatlantique; length between perpendiculars 326ft 6in, breadth 51ft 10in, load draught 15ft 7in, gross tonnage 4500, deadweight 1100 tons; service speed 18 knots (day), 14·5 knots (night); passengers, 165 first and 276 second-class, also 753 deck passengers; eleven watertight compartments, three complete decks, two 10-ton and four 5-ton derricks; four 330kW diesel-driven alternators; four S.E.M.T.-Pielstick, each of 2000 h.p. at 440 r.p.m., drive two propellers at 185 r.p.m. through A.S.E.A. reduction gears. Trial, December.

INDUSTRIAL NEWS

Iron and Steel

As reported on page 417 of our last issue, the British steel industry achieved a record output of ingots and castings during the month of February. Steel production was running at an annual rate of over 25,000,000 tons and it is estimated that the industry is now operating at about 98 per cent of its installed capacity. The Iron and Steel Board has stated that, in the final quarter of last year, steel consumption was 12 per cent higher than in the comparable quarter of 1958, though it was still about 3 per cent below the high level which was reached in the third quarter of 1957. Steel stocks held by private industry began to increase once again in the last quarter of 1959, although this was accompanied by a heavy fall in stocks held by public organisations. The continued rise in steel production in January and February this year, the Board adds, indicates that consumption is increasing further and that stock building is probably now taking place on a substantial scale, at least in the private sector of industry.

The Board also says that the results of the annual survey of capital expenditure in the iron and steel industry show that expenditure in 1959 amounted to £99,000,000, compared with £105 million in 1958. It is considered that the actual expenditure this year on capital development is likely to be of the order of £120 million to £125 million. A large part of the increase over the 1959 expenditure is due, of course, to the strip mill programme.

Overseas Trade

The Board of Trade's provisional figures show a value of £295,800,000 for exports of United Kingdom goods in February. Imports have been valued at £364,400,000 and re-exports at £9,400,000. After eliminating normal seasonal variations, exports in the three months December to February were 4½ per cent higher than in the preceding three months and were 9 per cent above the average for the whole of last year. On the same basis, imports in the last three months were 12 per cent above the average for 1959.

Commenting on the February export figures, Mr. F. J. Erroll, Minister of State, Board of Trade, described them as a gratifying improvement. But it was clear, he added, that this country could not afford to relax its export effort in the slightest if the imports demanded by its rising activity and prosperity were to be maintained.

Industry in Malta

Some information concerning the future industrial development of Malta was given at a press conference in London on Monday. The Secretary of State for the Colonies, Mr. Iain Macleod, explained that the Government's aim was to help to set up a new pattern of economic development to assist Malta to become self-supporting. Two boards, he said, had been formed to help forward the work of industrialisation. The first of them was the Aids to Industries Board in Malta which was responsible for making final recommendations on applications for assistance; the other being an Industrial Development Board, established in London, with Sir George Dowty as chairman, to advise the Governor on industrial development in Malta and to give guidance to the Aids to Industries Board on general principles and in assessing the worth of particular applications.

The incentives offered to industrial undertakings considering development in Malta include exemption from income tax for a period of up to ten years; loans or grants of up to 33⅓ per cent and in special cases up to 50 per cent of the cost of fixed capital assets (including plant, buildings and machinery) and customs duty relief on plant and machinery and on building materials for the construction of factories. Factories at very low rentals can be made available, there are no local government rates or property taxes in Malta, and there are the advantages of the Empire preferential tariff rates. In addition to the major undertaking for converting the dockyard in Malta to commercial use, six schemes for setting up new industries have already been approved. Another fifteen applications are being considered and the first factories on the new industrial estate have been allocated.

Chamber of Shipping Report

The Chamber of Shipping of the United Kingdom has issued its report for 1959–60 which stresses the need "to face the facts however unpalatable they may be." For over a century the industry, entirely without protection, has had to fight international competition, competition which, the report comments, has grown in intensity, especially since the last war. That this wind of change is no gentle breeze is shown by the fact that Great Britain's share of the world fleet has shrunk to one-sixth from one-half during the last fifty years. Since 1945 the 11,500,000 tons of shipping lost during the war have been replaced despite large increases in building costs. This, however, has imposed a severe drain on the shipowners' financial resources so that what remained was, according to the report, not sufficient to cover fleet expansion at the same rate as some other countries. Attention is drawn to the erosion of resources by taxation and the report points out that the industry must be permitted to create reserves during good trading periods in order to survive periods of depression. The initial allowance of 20 per cent is described as a palliative and the greater benefit of the 40 per cent investment allowance acknowledged, with the reservation that it only gives relief from tax when there are earnings against which it can be set. The difficulties and restrictions under which British owners operate are compared in the report with those of others who can operate their fleets under flags of convenience. Comment is also made upon present uneconomic development wherein some countries subscribe to the fallacious idea that a national marine is essential to national economy. On the subject of flag discrimination, the report notes that the United States, despite its own cargo preference policy, was quick to take action against another country practising discrimination. Retaliation against flag discrimination could result in the ridiculous state of affairs in which ships carry freight in one direction only. Other adverse factors mentioned in the report are building and operating subsidies made by some countries and the expansion of air traffic by means of economy fares.

Agricultural Machinery

According to the Agricultural Engineers' Association, Great Britain's exports of agricultural tractors last year were 22 per cent higher than those of Germany, which is this country's principal competitor. But Great Britain's exports of agricultural machinery last year, apart from tractors, declined by £750,000 or so, compared with 1958. The principal factor was a drop in overseas sales of combine harvesters which more than accounted for the whole of the decline. It should be noted, however, that combine harvester manufacturers established in this country have been opening up factories abroad, thus inevitably reducing the level of their sales from Britain itself.

This country's three leading overseas markets for agricultural machinery last year were the same as in 1958, namely, the Irish Republic, Australia and Yugoslavia, in that order. Elsewhere, the most striking trend was the increase in exports to the U.S.A. which, last year, at a value of £826,466, were nearly double those of 1958. Good increases were also secured in sales to the Common Market countries in Europe, with the exception of France.

Engineering Statistics

The latest set of engineering statistics issued by the Board of Trade shows that last year was a period in which the production of mechanical engineering and electrical goods expanded rapidly in this country. After the end of the first quarter of 1959, the Board of Trade says, the growth continued at an even pace until near the end of the year. In the first four months of 1959, engineering output was 1 per cent higher than a year earlier, in May and June 5 per cent higher, in the third quarter 9 per cent higher and in the fourth quarter, it is estimated, output was again 9 per cent higher than a year earlier. The check to the rate of growth of engineering output in the closing months of 1959 was due to a slackening of demand for consumer durable goods, especially radio and television sets, which had been mainly responsible for the rapid expansion earlier in the year. This faltering in production of consumer goods, however, was in part offset by an increase, beginning in the third quarter of the year, in deliveries of engineering capital goods.

The Board of Trade adds that the total volume of exports of the products of the engineering and electrical goods industries in the fourth quarter of last year was 6 per cent more than in the comparable period of 1958; for the year as a whole it was only slightly more than in 1958. Throughout last year, orders on hand for engineering and electrical products, mainly capital goods, were fairly steady but there was some increase in November and December.

Enter No. 211 on reply card

PERSONAL AND BUSINESS

Appointments

MR. E. F. D. WEBB has been appointed engineering manager of Hagan Controls, Ltd.

MR. MICHAEL WORMALD has been appointed London area manager of Firth Cleveland Pumps, Ltd.

MR. I. B. COOKE has been appointed director and general manager of the Industrial Fan and Heater Company, Ltd.

MR. R. GORE, M.I.Mech.E., has been appointed to the newly-created post of facilities manager of F. Perkins, Ltd.

MR. G. J. W. TURNER, chairman of Wrights' Ropes, Ltd., has joined the board of the Lancashire Steel Corporation.

MR. J. F. WINTERBOTTOM, A.M.I.E.E., has been appointed chief engineer of Data Recording Instrument Company, Ltd.

MR. F. H. SHEPHEARD has been appointed manager of Perkins Engines, Ltd.'s, Spanish, Portuguese and South American export sales zone.

THE BOARD OF TRADE announces that Mr. J. Leckie has been appointed to be a second secretary of the board, with effect from March 21.

MR. W. J. WYERS has been appointed products assistant chief designer to the research and development department of Rubery Owen and Co., Ltd.

MR. V. G. SWANSON has been appointed chairman of the Melbourne Harbour Trust, following the retirement of Mr. A. D. Mackenzie, who held the post for twenty years.

WELLWORTHY, Ltd., announces that Mr. A. D. Law, M.I.Mech.E., has joined the company as chief engineer, and Mr. C. F. Nossiter, A.M.I.Mech.E., as chief development engineer.

JOHNSON AND PHILLIPS, Ltd., announces that Mr. A. B. Adam, secretary of the company, has retired, and that Mr. N. D. Mathie, assistant secretary, has been appointed to succeed him.

MR. R. J. WELSH, M.I.Mech.E., has resigned from the board of directors of the Glacier Metal Company and has taken up an appointment as managing director of Herbert Hunt and Sons, Ltd.

MANUFACTURERS EQUIPMENT COMPANY, Ltd., states that Mr. W. G. Friggens, A.M.I.E.E., has been appointed director and general manager. Mr. L. D. Dale has been appointed sales director.

METAL INDUSTRIES, Ltd., announces that Mr. Horace White, group public relations officer, will in future have the title of group publicity controller. Mr. Desmond Cavanagh is to join him shortly as an assistant.

MR. DOUGLAS LANG has been appointed chief sales engineer of the aircraft equipment division, The English Electric Company, Ltd., Bradford. He has succeeded Mr. T. E. Simms, who has become chief project engineer.

MR. W. PIGDON, general manager of the Wells factory of E.M.I. Electronics, Ltd., is leaving shortly to take up a new appointment as executive vice-president of E.M.I.-Cossor Electronics, Ltd., Halifax, Nova Scotia, Canada.

THE BRITISH INDIA STEAM NAVIGATION COMPANY, Ltd., has announced that Sir William Currie is to relinquish the chairmanship on March 31, but will retain his seat on the board. Mr. E. J. Pakes has been elected to succeed him as chairman.

THE RIGHT HON. AUBREY JONES, M.P., has been appointed a member of the board of directors of Guest Keen Iron and Steel Company, Ltd., and will also act in an advisory capacity to the Guest, Keen and Nettlefolds Group on economic affairs.

WELDCRAFT, Ltd., states that the following additional representatives have been appointed to its sales force: Mr. R. Gladwell, N.W. London; Mr. J. Pollard, S.W. London; Mr. M. Bailey, Midlands. Mr. J. T. Roberts has been appointed agent for East Anglia.

THE MINISTRY OF POWER has appointed Mr. A. H. F. Linton, A.M.I.E.E., deputy chief engineering inspector of the Ministry, and Mr. C. D. Buchanan, A.M.I.C.E., principal planning inspector, Ministry of Housing and Local Government, to hold a public inquiry into the proposal by the Central Electricity Generating Board to build a nuclear power station at Oldbury in Gloucestershire. The inquiry will be held at Cossham Hall, Chapel Street, Thornbury, Gloucestershire, at 10.30 a.m. on Tuesday, April 12.

AIR COMMODORE J. F. ROULSTON has been appointed Air Commodore Commanding the Aircraft and Armament Experimental Establishment, Boscombe Down, Wilts. He succeeds Air Commodore A. E. Clouston, whose tour of duty at the Establishment ends this month.

THE COLLEGE OF AERONAUTICS announces the appointment of Mr. John Romaine Ellis, A.M.I. Mech.E., as Professor of automobile engineering and first director of the advanced school of automobile engineering being established at Cranfield, in Bedfordshire, in association with the College of Aeronautics. He will take up his appointment on June 1.

Business Announcements

ANDREW FRASER AND CO., Ltd., has moved from 29, Buckingham Gate, to 64/65, Vincent Square, London, S.W.1 (telephone, Victoria 6736).

MR. KENNETH D. FOSTER, chairman and managing director of Foster Brothers, Ltd., Wednesbury, Staffordshire, is on a business trip to the United States and Canada.

UNITED DOMINIONS TRUST, Ltd., states that its regional and branch office in Newcastle has moved to new premises at 12, Mosley Street, Newcastle upon Tyne, 1 (telephone, Newcastle 29515/8).

PELAPONE ENGINES, Ltd., of Derby, announces a change of name to Pelapone, Ltd. The company has been associated with engine manufacture for fifty years but its old name tended to misrepresent the current field of activities which is now increasingly concerned with electrical control gear and equipment.

FORD MOTOR COMPANY, Ltd., Dagenham, announces that as a further step in the development of its industrial engine business, a new sales operations group has been formed. The new operation is headed by Mr. G. T. Jones, manager, industrial engine sales operations, with Mr. G. J. Carroll, manager, overseas sales, and Mr. W. R. H. Temple, manager, United Kingdom sales.

THE ENGLISH ELECTRIC VALVE COMPANY, Ltd., Chelmsford, Essex, and Eitel McCullough Incorporated, U.S.A., have concluded an agreement for the exchange of technical information and manufacturing experience over a large range of klystrons, travelling wave tubes and power tubes. This agreement will enlarge the variety of tubes offered by both companies and expedite production of a composite range by each maker.

MICROCELL, Ltd., announces the formation of a new subsidiary company known as Glass Yarns Machinery, Ltd., 9, Kingsway, London, W.C.2 (telephone, Covent Garden 1262). The board of directors comprises Mr. Henry Kremer, Mr. D. J. Hodgson and Mr. D. Crashaw, executive director. The new company is manufacturing specialised plant for the reinforced plastics industry, including glass fibre preform moulding machines and preform drying ovens.

TAREX (ENGLAND), Ltd., until now sales and service company for Tarex S.A., Geneva, announces its appointment as sole selling and servicing agent in Great Britain for Hasse and Wrede G.m.b.H., Berlin, manufacturer of multi-spindle hydrocopying automatics, 26in twin turret hydrocopying automatics and small transfer machines, as well as for Maschinenfabrik Gustav Strohm, Schwenningen (Neckar), maker of Swiss type head precision automatics.

Contracts

HAWKER SIDDELEY NUCLEAR POWER COMPANY, Ltd., has received from the Dutch Nuclear Research Centre (Reactor Centrum Nederland) an order for a 10kW "JASON" research and training reactor. The "JASON," which will be operating in August, is to be installed as a low flux reactor at Petten, north of Amsterdam, and will be complementary to the high flux reactor under construction there. It will be the first small British reactor on the Continent, and will be similar to the "JASON" reactor opened at the Hawker Siddeley works at Langley, Slough, last year (THE ENGINEER, December 4, 1959).

THE ENGLISH ELECTRIC COMPANY, Ltd., has received an order from the Indian Railway Board for ten complete electrical equipments to be installed in 3600 h.p., 1500V d.c. locomotives which will be built in India at the Chittaranjan Locomotive Works. These ten locomotives will be generally similar to the seven with the C_0–C_0 wheel arrangement which were supplied complete by The English Electric Company, Ltd., in 1955, for service on the Bombay-Poona and Bombay-Igatpuri sections of the Central Railway (formerly Great Indian Peninsula Railway). The new series will be the first electric locomotives to be built in India. Fitting, erection and testing will be carried out in collaboration with English Electric staff.

SIR HOWARD GRUBB PARSONS AND CO., Ltd., has received an order from the Admiralty for the design and manufacture of a 98in Isaac Newton telescope. The instrument will be a reflecting telescope of 98in aperture and will use an existing low-expansion glass disc, which has already been partly worked. The telescope will be designed for use at the Prime focus, Cassegrain focus and Coude focus. Particular attention will be paid to its suitability for a programme of faint star astrometry, which will form an important part of the Royal Observatory's programme of work with the instrument. The telescope is expected to be installed in the grounds of the Royal Greenwich Observatory at Herstmonceux Castle, Sussex, in 1966.

ASSOCIATED ELECTRICAL INDUSTRIES EXPORT, Ltd., is to supply two 300MW steam turbine-generator sets for the Lakeview power station (near Toronto) of the Hydro-Electric Power Commission of Ontario. The sets will be 3600 r.p.m. tandem-compound turbines and direct-coupled a.c. generators, three-phase, 60 c/s at 18kV, 0·85 p.f., and the exciters will be motor driven. The turbines will be four-cylinder machines: steam conditions 2350 lb per square inch gauge, 1000 deg. Fah. at the turbine stop valve. Before the i.p. cylinder the steam will be reheated to give 1000 deg. Fah. at the i.p. inlet. From the twin double-flow l.p. cylinders the steam will exhaust to condensers at a vacuum of 29in Hg. The generators, of caged-core construction, will incorporate rotor cooling by hydrogen at 30 lb per square inch gauge, together with the A.E.I. system of direct-water-cooled stator windings. The first machine is to be commissioned in September, 1963, and the second in September, 1964.

Miscellanea

HACKSAW BLADES.—A new form of high-speed hacksaw blade now made by J. Stead and Co., Ltd., Cricket Inn Road, Sheffield, 2, is hardened on the teeth only. This method of hardening the teeth only is stated to incorporate in the blade the flexible properties of low tungsten with the superior cutting ability of high-speed steel to reduce chance of blade breakage by unskilled use. The new $\frac{1}{2}$in blades are made in 10in and 12in lengths with a number of generally used teeth pitches.

ALLOY PLUG VALVES.—A range of plug valves in which need for lubrication, likely to contaminate a product in chemical food or similar processing plant, is eliminated, is now made by Langley Alloys, Ltd., Langley, Slough, Bucks. These "Langalloy-Durco" valves have a sleeve of P.T.F.E. interposed between the plug and the body. The P.T.F.E. used is stated to be suitable for valves operating at temperatures up to 400 deg. Fah. The valves are available in stainless steel, nickel alloys and other metals in which standard Langley valves are produced. When necessary new sleeves can be quickly and easily fitted in the valves.

SYMPOSIUM ON GROUTING PRESTRESSED CONCRETE.—A symposium on Grouting Prestressed Concrete will be held under the auspices of the Fédération Internationale de la Précontrainte and R.I.L.E.M. in Trondheim, Norway, from June 20 to 22, 1960. The conference will cover a wide range of problems, and, in particular, the properties of grout. It will be supplemented by an exhibition and demonstrations of modern grouting equipment. Contributions for presentation at the symposium should be sent for consideration to Professor I. Lyse, Norges Tekniske Hogskole, Trondheim, Norway.

AUTOMATIC BOILERS.—The Telegraph Construction and Maintenance Company, Ltd., Mercury House, Theobald's Road, London, W.C.1, has introduced an automatic boiler for space heating and hot water supplies which is to be known as the "Telcomatic," and which is manufactured under licence from Dutch patentees. The boilers are designed for firing with either oil or most solid fuels, ranging from coke or low-grade steam coals to anthracite. Whether working on solid fuel or oil, the boiler is fully automatic, and a minimum efficiency of 85 per cent is guaranteed throughout the range, from the smallest boiler with a capacity of 500,000 B.Th.U. per hour to the largest with 10,000,000 B.Th.U. per hour.

CONTINENTAL AFFAIRS

by Our Continental Editor

Leipzig Spring Fair

No. II—(*Concluded from page* 448, *March* 11)

FOR machining the ends of heavy steel tubes up to 400mm diameter the V.E.B. Maschinenfabrik John Schehr, Meuselwitz, has developed the tube-ending lathe shown in Fig. 8. This machine, the model "DXR 400," makes it possible to cut off, face, and thread the tube. Thread-cutting is carried out by means of a form-copying device.

For the driving of drainage headings in opencast lignite mines, V.E.B. Bergbaumaschinen, Seehausen, has developed the machine illustrated in Fig. 9. The cutter has an advance capacity of 5m per hour, the heading section being 2m high, and 1·8m wide at the bottom and 1·5m at the top. With a weight of 5 tonnes, the machine is 1650mm high and 4600mm long, and has a width (in transport) of 1100mm.

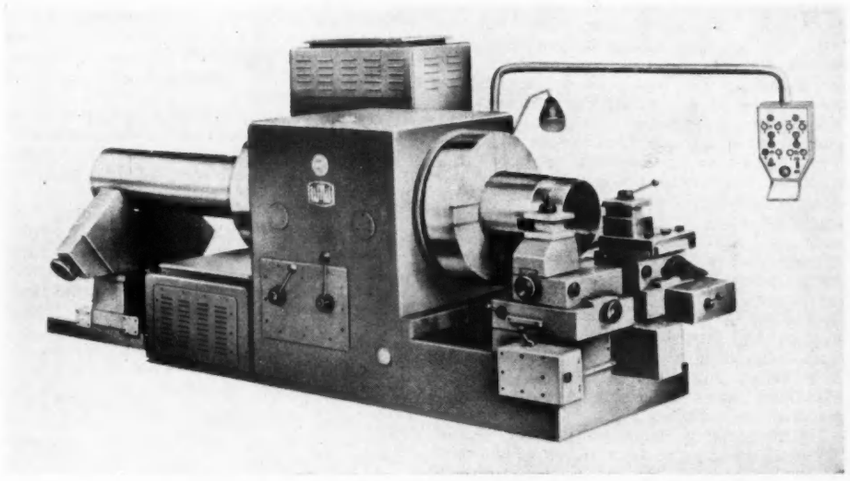


Fig. 8—Tube-ending lathe for heavy steel tubes

A large number of cranes of various designs were on view including heavy tower jib cranes for building construction and cranes for the handling of goods in ports and warehouses. Fig. 10 shows a dock crane made for Belgium by V.E.B. Kranbau Eberswalde. The crane has a capacity of 3·2 tonnes at 32m radius and 6 tonnes at 18m.

The universal loader introduced by the Institut für Fördertechnik (Institute for Materials Handling), Leipzig, comprises a 4·35m long by 2·28m broad chassis fitted with a 52 h.p. diesel engine and equipped with driving cabin. By adding interchangeable attachments, it is possible to convert the machine to a variety of uses, including a crane (1 tonne capacity at 4·55m, 1·7 tonnes at 2·7m), a universal power shovel of 0·5 cubic metres volume and a width of 1·5m, a bulldozer with a 2·5m long blade, a working stage of 200 kg carrying capacity covering a range of working heights from —0·8m to 5·16m, &c. The machine is operated hydraulically and on pneumatic tyres has a speed range of 1·89–19 km per hour, while as a half-track its speed is 0·95–9·5km per hour. The loader has a minimum turning radius of 4·8m and weighs 7·82 tonnes.

In the section devoted to rail transport V.E.B. Waggonbau Gotha exhibited a four-axle, articulated tramcar for thirty-five seated and 144 standing passengers. The vehicle is equipped with underfloor controller, fluorescent lighting, a loudspeaker system, and automatic doors. The central section is carried on rubber springs by means of two turntables.

For express and goods services V.E.B. Lokomotivbau-Elektrotechnische Werke "Hans Beimler," Hennigsdorf, has developed a 135-ton C_0-C_0 locomotive with an hourly rating of 3180kW. Built for 3kV d.c., the locomotive, of which a model was exhibited, has electro-pneumatic controls. The locomotive is for 1524mm gauge and has a length over central couplings of 18,500mm; the driving wheel diameter is 1350mm. At hourly rating at 48·5km per hour, the tractive effort is 23·5

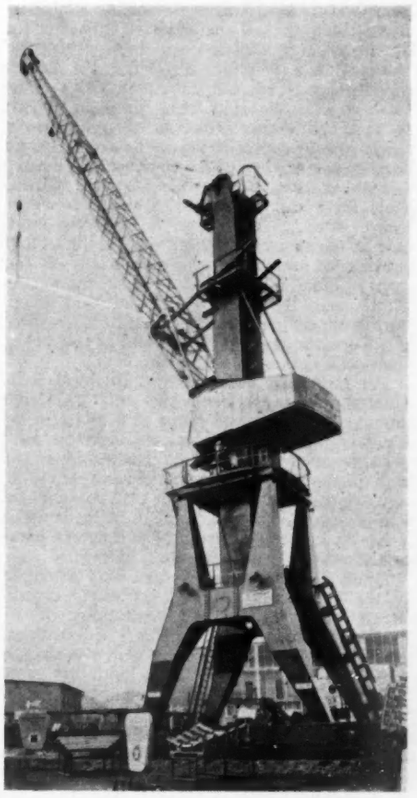


Fig. 10—Harbour jib crane

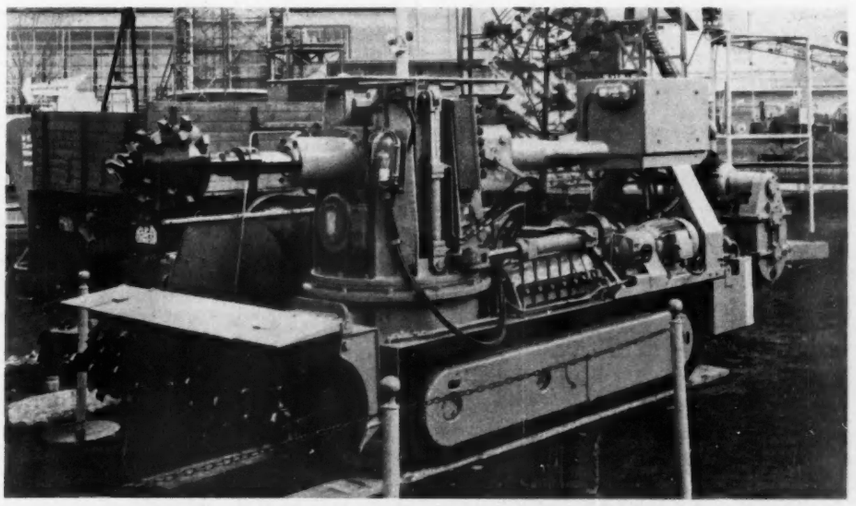


Fig. 9—Cutting machine for drainage headings in opencast lignite mines

CONTINENTAL AFFAIRS *(Continued)*

tonnes; maximum tractive force is about 40 tonnes, and the maximum speed is 110 km per hour.

Fields in which West German exhibitors were particularly numerous were mining and earth-moving plant, and also materials handling equipment. One of the new developments from among the earth-moving machines exhibited was the "HL 290/R" shovel loader of Salzgitter Maschinen, Aktiengesellschaft, Salzgitter-Bad. This tracked machine is intended for mining galleries with low headroom (1800mm–1900mm) and is powered by five air motors (one driving an oil pump) totalling 51 h.p. The 1300mm wide shovel is wider than the chassis so that the vehicle clears its own path in a single journey without the need to manœuvre backwards and forwards. Together, the bunker and shovel have a capacity of 1·25 cubic metres; the bunker can be discharged by a conveyor in five seconds. The shovel is supported on a pair of spiral cams running on flat tracks and constrained by chains winding on and off the cam surfaces to rotate without slip during the translation. By virtue of the spiral cam shape, during the early part of the movement the force is greatest, while towards the end of the stroke the velocity attains its maximum.

For producing boreholes in hard rock, Salzgitter showed the mobile rotary drill "SG 750," having a stepless speed range of 0–90 r.p.m. or 0–630 r.p.m., and a steplessly variable drill pressure of up to 6 tonnes. The stroke of the drill spindle is 750mm. A special valve hydraulically balances the weight of the drill string which with a height of the rig of 6·32m is made up of 2·5m or 3m long sections. The range of borehole diameters is from 56mm to 215mm.

Heavy oil drilling equipment was exhibited by the Engineering Works "1st May," Ploesti, which gave working demonstrations of its "2DH-75" and "4 LD-150A" installations, one for drilling to 2000m depth with 4½in strings, the other for attaining 3500m with the same string size. The larger rig is designed to carry a hook load of up to 185 tonnes and develops a power at the drill table of 1400 h.p. A full range of equipments, including hooks with capacities up to 200 tonnes was shown by the same factory.

Among the wide range of exhibits shown in Hall 4 by Czechoslovakia, a prominent place was occupied by products of the machine tool industry. As an example we mention the "FRO 8" plano-milling machine made by the TOS factory, Kurim. As may be seen from Fig. 11, this is a high-duty single-column machine equipped with horizontal and vertical spindles. The vertical headstock is mounted on a cross rail which for extra rigidity is additionally supported at its outer end. The machine may be controlled from the pendant, or automatically by means of a punched tape.

The "IMO-S" checking equipment for gears and gear cutting machines, following its debut at Brno last September, was being shown for the first time outside Czechoslovakia. The equipment makes ingenious use of a magnetic disc containing on its circumference the magnetic recordings of sinusoidal magnetic fields. This disc sits on a shaft mounted on the face plate of the gear cutting machine. Recording and tracing heads are fitted, the electric part in addition to these devices comprising an amplifier, phasemeter, and control panel. The equipment, which is portable and weighs 100 kg, permits the separate measurement of worm and worm wheel errors, over a range of gear ratios of 1 : 50 to 1 : 1000, with an accuracy of 0·5 second of angle. Results of such measurements make it possible to lay out correcting cams, as well as checking the performance of the gear cutting machine at any time.

An automatic precision level was introduced by V.E.B. Carl Zeiss, Jena. The "KONI 007" uses as compensator a pendulum supported on flexure pivots and provided with air damping. The pendulum is insensitive to rough handling and practically dead-beat. It incorporates a suitable right-angle prism as part of the optical system of the telescope. As a result, the main portion of the internal optical path is in the vertical direction so that a periscope effect is obtained which can be of advantage, e.g. when using the instrument in a crowded street, and also helps to reduce the effects of atmospheric refraction. The parallel plate micrometer can be used optionally depending on the required accuracy. Levels can be measured to within ±0·5mm to ±0·8mm per kilometre. The coated telescope with focusing from 2·2m to infinity, has a magnification of 31·5 times, and readings of the graduated horizontal glass circle can, it is stated, be estimated to one minute of arc.

British participation centred on the United Kingdom Pavilion of over 15,000 square feet, which for the first time had been co-ordinated by British Overseas Fairs, Ltd. In spite of the increased size of the British pavilion, many firms could not be accommodated there, so that some 17,000 square feet of stand space were taken up elsewhere, notably in the metallurgical, machine tool, and electronic sections. The main item on display by The English Electric Company, Ltd., London, W.C.2, was a complete constant frequency a.c. generating system for use in airliners, made by the company's Aircraft Equipment Division, Bradford. The system includes two constant-speed drives and two 40kVA brushless generators. Also shown was the latest development in d.c. brushless generators, a 9kW machine suitable for installation on medium-sized turbine engines fitted in fixed or rotating wing aircraft. Brushless generators in such applications are stated to be advantageous because of their longer life between overhauls.

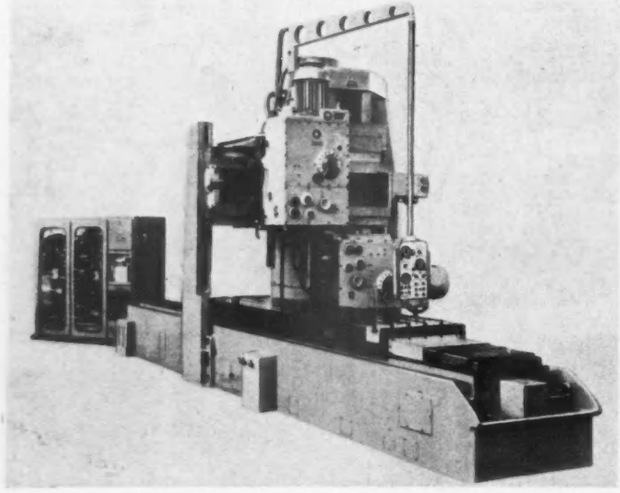


Fig. 11—Plano-milling machine "FRO 8"

A full range of products were shown by D. Napier and Son, Ltd., London, W.3, including "Eland" and "Gazelle" gas turbine engines, and "Deltic" diesels. Exhibits included the model of the "C-045" turbo-blower which is to be marketed shortly. These machines, with a pressure ratio of 2·5 : 1 continuous rating—higher compression being possible for short periods—cover a delivery range of 0·155 to 4·6 cubic metres per second of free air, and will be available in sizes of 100 h.p., 200 h.p. and 300 h.p.

The Griffin and George Group, Alperton, Wembley, showed a range of its latest laboratory equipment. In a wide selection of electrical and electronic measuring devices may be mentioned the Griffin-Clarkesmith Mechtronics set for demonstrating the principles of electronics.

Conference and Annual Meeting of S.B.M.

On the occasion of this year's Annual Meeting of the Société Belge des Mécaniciens, which will take place on March 28 at 21, rue des Drapiers, Brussels, a conference is being organised in collaboration with the Belgian Institute of Welding. The programme includes the following lectures: "Fundamental advances in Metals Fatigue" (Professor M. Massonet, Liège); "Examples of Accident Studies in relation to the stability of various mechanisms and assemblies" (M. Bourceau, chief engineer, Bureau Veritas, Paris); "Fatigue and Welding" (M. de Leiris, president of the Fatigue Testing Committee of the International Institute of Welding, and president of the French Metallurgical Society); "Influence of surface finish on resistance" (MM. Mossoux and Collin, F.N. Central Laboratory); "Measurements of surface conditions" (Professor M. Bodart, Liège); "Measurement of small differences in liquid level" (Professor M. Van Eepoel, Brussels). Persons wishing to attend are asked to contact the S.B.M. Secretariat, 21, rue des Drapiers, Brussels, 5.

Liège International Fair

The twelfth International Fair will take place at Liège during the period June 2–16 at the Coronmeuse exhibition grounds, which comprise 7 acres of hall space and 3 acres of open air site. The Fair, which last year attracted 250,000 visitors, will again be grouped under twenty-two industrial sections, covering mining equipment, metals and mechanical and electrical engineering. Four international conferences are scheduled to be held at Liège in the first half of June, dealing with welding, building, spectroscopy and factory safety and hygiene; these topics will be the subject of special exhibitions at the Fair. Full information is obtainable from the U.K. representative, R. C. Liebman, 178, Fleet Street, London, E.C.4.

Utrecht Technical Spring Fair

From April 5-14, inclusive, at the Technical Spring Fair at Utrecht, some 1830 firms from twenty-five countries will show machinery and equipment, including a large section devoted to the building industry. This will comprise an open-air exhibition of building machines, as well as exhibitions of materials, handling equipment and equipment for heating, ventilation, and refrigeration. Also included in the exhibition will be sections dealing with metal and woodworking machinery; raw materials and semi-products; pumps, compressors and internal combustion engines; and office, school, and large kitchen equipment.

THE AMERICAN SCENE

by Our American Editor

Aircraft and Missile Application of Molecular Electronics

The U.S. Air Force and the Westinghouse Electric Corporation recently demonstrated how the new concept of "molecular electronics" may influence developments in the electronics industry and extend man's reach into space. At the same time, there were demonstrated a variety of working sub-systems which are vastly more reliable and as much as 1000 times smaller than the most advanced electronic devices in use to-day. New systems, employing these concepts, could be operational in missiles or satellites within three to four years to perform such functions as telemetering light intensity or radiation levels back to Earth, and providing infra-red detection and reconnaissance information, flight guidance and communications.

THE current efforts to elevate air and space craft to new levels of capability are continually made more difficult due to a technical paradox. As these craft become more "sophisticated" through the use of advanced electronic gear, the risk of failure among components and connections grows. Furthermore, as one adds this more complex electronic equipment, it becomes more difficult to provide for its weight and size. As a result, various programmes for the improvement of reliability and weight and size reduction of electronic equipment are now being conducted by the U.S. Air Force and the Westinghouse Electric Corporation. It has been found that these problems may be approached in several ways. For example, improved reliability can be realised by better quality control on components and connections. However, the probability of simultaneous successful operation of all components in any system is the product of all the individual probability of a component functioning without failure, and better quality control does not invalidate this limitation imposed by the laws of probability. Smaller and lighter components in more compact packages can be obtained by miniaturisation, but such techniques, while exploiting modern technology, do not yield maximum reliability. On the contrary, the emphasis placed on size and weight reduction has usually meant that components and internal connections become so critical that they must be built with extreme precision if their failure rate is to be acceptable.

In the recent past, a substantial part of the Westinghouse research and development effort has been focused on a new and quite distinct approach to both problems. It exploits a new concept in the design and functioning of electronic systems. It is a broader concept of electrical engineering, which has been called "molecular electronics" to indicate its dependence on phenomena occurring within or between domains of molecules in the solid state. Recognising the potential importance of this concept to defence, the Wright Air Development Division's Air Force Electronic Technology Laboratory has directed the employment of Westinghouse facilities in a programme to prove its feasibility. Its specific objectives were: to determine to what extent molecular electronics could be used to perform complex functions in several systems of basic importance to the U.S. Air Force; to develop sub-systems for use in those systems; and to develop new materials that would advance the usefulness of the concept.

Function Blocks

As one accomplishment of the joint programme, the firm is now producing a variety of molecular electronic "function blocks," three of which are shown in Fig. 1, as solid-state elements that achieve, entirely within themselves, electronic results which previously could be gained only by assembling many, varied items of electronic "hardware." Because of this, these elements are not intended as "components," such as transistors and valves, but rather as "sub-systems," since each of the function blocks has the ability to achieve an electronic result, which is essential if all the sub-systems in the entire system are to work together effectively. Examples of functions performed by function blocks are electronic operations such as amplification, oscillation and telemetering.

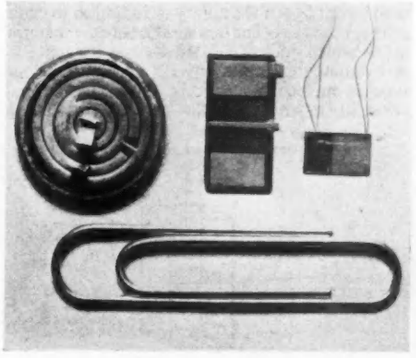
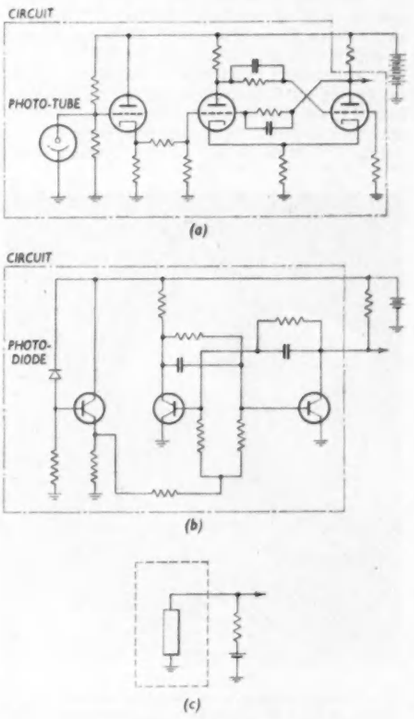


Fig. 1—Three molecular electronic function blocks: audio-amplifier (left); free-running multi-vibrator (centre); and two-stage video-amplifier (right)

Because there are no internal connections or components, and the only external connections needed are those for coupling inputs and outputs to the complete system, one is able to build sub-systems whose risk of failure should be equal to or less than that of familiar solid-state devices, and perhaps one-thousandth of that of a sub-system built up of many parts for the same purpose. This ability of molecular electronics to reduce the number of components and connections required is illustrated by a comparison of three designs for a light telemetering sub-system in Fig. 2. When designed to use electronic valves, this sub-system required sixteen components and eighteen soldered connections; when designed to use transistors, it required fourteen components and fifteen connections. In contrast, when developed as a molecular electronic sub-system to achieve the same purposes, there now is needed but one component and two connections. Because their internal functions involve distances of the order of a few atomic spacings, these function blocks are almost microscopically small and virtually weightless. For example, the weight of the above light telemetry sub-systems was reduced originally from about 1 oz to ¼ oz, and subsequently to about seven ten-thousandths of an ounce.



(a)

Data (approximate):	
Volume	4 cubic inches
Weight	26 grammes
Input power	5W
Number of components	16
Number of soldered junctions	18

(b)

Data (approximate):	
Volume	1 cubic inch
Weight	7 grammes
Input power	0·75W
Number of components	14
Number of soldered junctions	15

(c)

Data (approximate):	
Volume	Less than 0·001 cubic inch
Weight	0·02 grammes
Input power	0·06W
Number of components	1
Number of soldered junctions	2

Fig. 2—Light telemetering sub-system circuits using (a) valves, (b) transistors, and (c) a molecular electronic element

As a result of the joint programme, eight classes of function blocks have now been developed to demonstrate the feasibility of molecular electronics at frequencies ranging from infra-red to direct current. These function blocks are:

THE AMERICAN SCENE *(Continued)*

(1) a 5W directly-cascaded audio amplifier ; (2) a two-stage video amplifier ; (3) a frequency-selective amplifier with notch filter in a feedback loop around the amplifier structure ; (4) a variety of multi-vibrators—bistable, monostable and astable ; (5) a variable potentiometer based on the logarithmic addition of two inputs ; (6) a variety of multi-position switches, including an " OR " switch, a multiple NPNP " Dynistor " switch, and a multiple NPNP " Trinistor " switch with firing electrode ; (7) an analogue-to-digital converter employing an NPNP relaxation oscillator ; and (8) a two-stage cooler, employing the Peltier effect, covering frequencies from 1 c/s or less to 3 Mc/s, for cooling infra-red detectors to proper operating temperatures.

Fig. 3 illustrates two audio amplifiers which

Fig. 3—Application of a function block as a 5W audio-amplifier in a conventional gramophone system

represent the equivalent of several stages of amplification and which have been developed for both low- and high-power applications. Shown as part of a gramophone system, the high-power amplifier is capable of 5W of output when fitted with a heat sink and a frequency range from zero to 20,000 c/s. Within the encapsulation is a tiny monolithic block which actually performs this amplification, and has a volume of about 0·001 cubic inch. Teamed with the high-level amplifier in this demonstration is a low-level amplifier functioning as a pre-amplifier. This pre-amplifier amplifies signals from microwatt to milliwatt levels.

In connection with its work with multi-

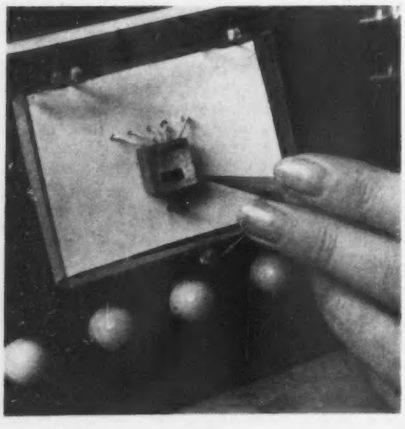


Fig. 4—Molecular electronic logic switch having five inputs

vibrators as devices that are essentially two-position switches, Westinghouse has developed a variety of molecular electronic switches. As one of these, the logic switch illustrated in Fig. 4 has five inputs, each of which can be supplied an incoming signal. Each output of the molecular switch is connected to an individual load. A momentary signal on any input will close the circuits to all the outputs. Hence, in this condition (turn-on) the functional block acts as an " OR " switch, i.e. an output results when an input signal is received on input one, on input two, on input three, and so on. In turning " off " the switches, the functional block acts as an " AND " switch. This means that all the inputs must have a signal applied to open the switch, in which case all the loads open.

An application for which this functional block might be useful would be in a count-down for missile launching. Once all stations involved had been cleared and count-down begun, a malfunction at any one station would cause a signal to trigger the switch, immediately providing at all other stations indication of the malfunction. However, once the malfunctioning had been corrected, the indication of malfunction could not be cleared until all stations had signified readiness by feeding back a readiness signal. Thus, any one station could actuate the switch for a malfunction, but all stations would be required to signal clearance. Once the fault was corrected, the logic switch would recheck all circuits before allowing the process to resume.

Operative Domains

As the basis for developing these molecular electronic sub-systems, there exists a very substantial knowledge of solid-state phenomena developed over the past thirty years. It is simple now to create materials having excessive positive or negative electrical charges and, by placing these materials in physical contact with related materials, to bring about such phenomena as rectification or amplification, as in diodes and transistors. Also, one can readily take advantage of the ability of radiation to cause charge paths to occur in a semiconductor material along which current will flow when the material is irradiated. Effects of this general type are used in molecular electronic blocks by creating —usually in single crystals—a number of distinct

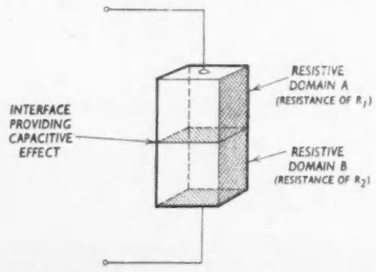


Fig. 5—Time-delay circuit function block having two resistive domains and one capacitive interface

operative domains, which can be regarded as molecular " communities " having a common civic purpose, in that each domain will sustain a desired electronic occurrence. The domains border one another at boundaries called interfaces, which are like political frontiers in their ability to initiate phenomena different from those occurring inside the molecular domains.

As a simple example in the element shown in Fig. 5, one sees that it is composed of two domains which meet physically at one interface. One of these domains is composed of a resistive material selected and shaped to present a resistance R_1 to the passage of current ; the other domain is also resistive but is planned so that it has a resistance R_2. At the interface, the interaction between domains causes a capacitive effect. Thus, in one tiny element one obtains a sub-system equivalent to a time-delay circuit. Another illustration of the uses of domains and interfaces is a function block designed as an a.c. to d.c. power supply for transistor circuits. It makes use of the Seebeck effect for the thermo-electric generation of electricity to convert 110V a.c. to 9V d.c. power. As shown in Fig. 6,

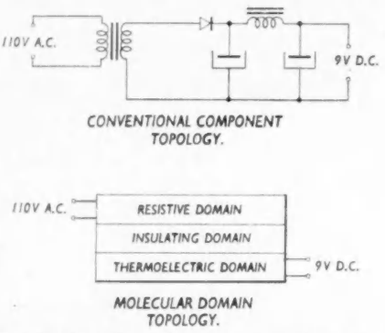


Fig. 6—Comparison of power conversion circuits employing conventional components and molecular domains

the conventional circuit requires five individual components—a transformer, a diode, and the inductive and capacitive elements making up the *LC* filter circuit. To do the same thing with molecular electronic methods, one employs a function block comprised of the three separate domains. When a.c. power is applied to the resistive domain, the heat that is generated passes through the domain at the centre—this domain is an electrical but not a thermal insulator—and into the thermo-electric domain where the energy is converted into electrical energy by the Seebeck effect. By proper control over the materials used, the block provides the 9V d.c. output desired. An interesting aspect of the power supply is that elimination of ripple as an undesirable variation in voltage is inherent, since heat flows from the resistive domain to the thermo-electric domain at practically a constant rate. As these two examples suggest, the concept of molecular electronics makes no use of the traditional circuit-and-component approach to electronics. Instead, the objective is to use knowledge of the structure of matter to synthesise monolithic function blocks whose arrangement and composition permit each to serve as a sub-station to perform an electronic function in the control or transformation of energy.

To achieve function blocks with this capability, a number of effects and phenomena of the solid state are available. The only firm limitations on choice are that the effect must not react adversely on system reliability and must lend itself to consistent results when included in a function block. Methods typical of practice so far include : solid-state phenomena, such as Seebeck generation, Peltier cooling and Hall-effect multiplication ; the use of PN semiconductor junctions arranged to produce a result which would otherwise require numerous individual components and, when necessary, fabrication of circuit elements within a function block. Although such phenomena will be most often used for the control of electrical signals, they will also be suitable when quantities like electromagnetic radiation, heat and mechanical displacement are inputs or outputs.

System Design

The design of a sub-system begins with the designer's analysis of the requirements of the system, to establish the functions to be performed by the function block. After logic processes are determined and suitable physical effects settled upon, a " topologist "—a mathematician who works with shapes—determines the structure of the block by designing, on paper, the arrangement of domains and interfaces that is to control

the flow of energy in the block. The block is then produced by the materials engineers, who use germanium and silicon as the basic semi-conductor materials. In production, these blocks are not assembled from various tiny components. Rather, one starts with a basic semi-conductor wafer and produces the necessary domains and interfaces by techniques used in the production of conventional semi-conductor devices, including diffusion, plating, electron beam machining, etching, cutting, radiation, alloying and photographic processes.

Although the function block so produced can now perform its function, additional processing steps are required to encapsulate the block, protect it against shock and vibration and make it stable under the conditions of temperature and radiation it will encounter. Thus, the dominant theme and the essential philosophy of molecular electronics is that one can now create, modify and process materials to endow them with the ability to accomplish electronic tasks through solid-state phenomena. The foundation of success has been the ability to develop new materials and to process available materials in new ways.

Dendrite Process

One important illustration of the contributions made by materials engineers is the development of a method for the rapid production of semi-conductor crystals in a form that requires no removal of material to make them into suitable wafers for use as transistors or as the basic elements of molecular electronic elements. This is the dendrite process announced several months ago, in which germanium crystals in the form of ribbons about ½in wide and a few thousandths of an inch thick, are produced by drawing them from a molten mass. In contrast, in the conventional method, germanium crystals are grown as thick ingots, or boules, which require X-ray or crystallographic inspection before they can be sawed into precisely oriented wafers and then must be lapped, etched and polished to obtain a satisfactory working surface. In addition to the waste of material and the cost of machining involved in the standard method, a serious disadvantage to its use for the production of molecular electronic blocks is the wide variation in characteristics frequently displayed by wafers, even by those cut from adjacent regions of a single ingot and processed identically. In the production of transistors, this difficulty can be circumvented by testing a production run to select those with proper values. In molecular electronics, however, it is necessary to build junctions in adjacent portions of the same crystal; thus, it is essential to have materials whose characteristics are uniform if the yield is to be acceptable.

Other advantages of this dendritic method of importance to molecular electronics are as follows. It is essentially a continuous process in which the germanium ribbon grows at a rate of 6in to 12in per minute and in the precise direction of crystal growth required for application. Thus, no X-ray or crystallographic examination is necessary and the surfaces of the ribbon are always correctly oriented, optically flat, and immediately usable as working surfaces. An additional advantage is that if a contaminant enters the melt during the process, the resulting inclusion is "self-healing," so that when the process is completed, the affected portion can be cut away and the unaffected portion put to use.

Although this dendritic method has immediate usefulness in molecular electronics to-day, it is felt that its greatest significance is its ability to bring about a number of completely new processes for producing functional blocks. A recent modification makes it possible and practical to carry out diffusion, plating and evaporation processes directly on the crystal as it grows from the furnace melt. With this technique, it is possible to create semi-conductor devices ready for the attachment of leads. One of the first uses has been to grow transistors in the form of a long germanium crystal. When the ribbon-like crystals are cut into segments, only simple processing is needed to produce transistors at a yield of very nearly 100 per cent. By this method Westinghouse has produced lengths of ribbon along which small multiple-junction sub-

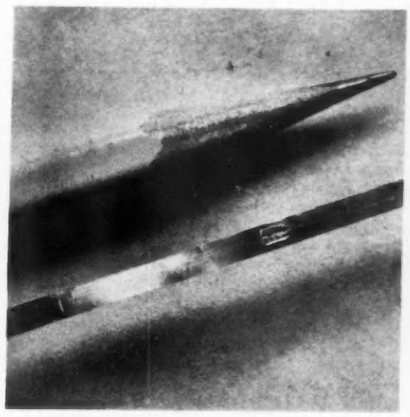


Fig. 7—Germanium ribbon produced by the dendrite process bearing multiple-junction systems

systems are distributed, as illustrated in Fig. 7. Since these ribbons can easily be processed to become a long series of tiny amplifiers, this ribbon can virtually be snipped into lengths to provide amplifiers of whatever gain desired.

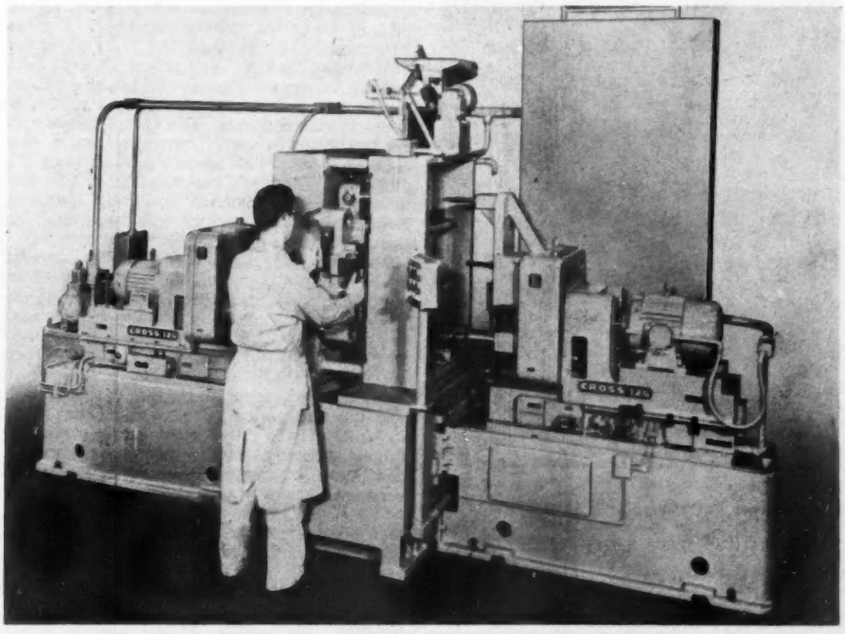
A more recent and extremely significant achievement resulting from this research is the discovery how to grow multi-zoned crystals as dendrites directly from the furnace melt. This development makes available basic building blocks having at least three layers of zones and two interfaces. Thus, it will no longer be necessary to perform many operations to create multi-zone elements. In considering the implications of this basic method for crystal growth, one very interesting possibility is that it will prove practical to combine the ability to grow multi-zoned crystals with the ability to perform operations on the crystal at the time it is growing in the furnace. Admittedly, to achieve nearly automatic production of semi-conductor devices and molecular electronic function blocks is a long-range objective, but it is probable that it will eventually be possible to "grow" from a pool of molten semi-conductor materials some items of electronic equipment that to-day are of the order of complexity of wireless receivers and amplifiers.

Present programmes of research at Westinghouse relate to such problems as the development of materials that will withstand very high temperatures and intensive radiation and the development of function blocks that will have high power handling capacities. Investigation now under way with the so-called 3–5 compounds supports the firm's approach to the development of heat and radiation-resistant materials; and the ability to produce large, perfectly flat working surfaces on crystals of germanium will help to increase the power-handling capacity of molecular electronic function blocks.

AUTOMATIC TRUNNION MACHINE FOR AIR BRAKE COMPONENTS

A LARGE manufacturer of air brakes has cut the cost of producing a whole "family" of seventeen different slack-adjuster arms by the use of a single automatic trunnion machine designed and built by the Cross Company, of Detroit, Michigan. Although the production of no one of the adjusters would justify the development of a special automatic machine, their combined production volume does. As shown in the accompanying illustration, the trunnion machine has four stations. It accurately drills, chamfers and reams the parts, and inserts bushings in from one to three holes in each of the slack adjusters. The key to the flexibility of this machine is the tooling that can be easily adjusted to handle the different workpieces.

Over a period of hard usage, the cable used to operate air brakes on heavy lorry trailers gradually develops slack. Adjuster arms are provided so that the cable link can be moved to take out the slack. Such slack adjusters could be mass-produced except that different trailer installations call for different designs. The differences are quite numerous and include amount of tang offset, number of holes, location of holes, distance of holes from the large central opening, size of the central opening and size of the adjustment holes. Of the seventeen designs now made on the single trunnion machine, five have only one hole, eleven have two holes, and one has three holes. They also vary as to position and combinations. There are seven different combinations of offset and eccentricity represented among the parts. One slack adjuster has two



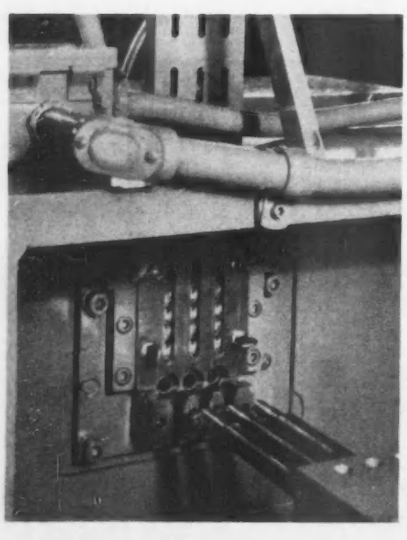
Cross four-station trunnion machine for producing seventeen different designs of slack adjusters

THE AMERICAN SCENE *(Continued)*

holes, but only one of these requires a bushing. All workpiece variations have been taken care of in the tooling design and it is probable that if other styles are required in the future, these also can be produced on the same machine.

The trunnion of this Cross machine is square. The parts are unloaded and loaded during the machining cycle at the front of the machine. Drilling and chamfering are accomplished in the lower station, reaming and chamfering are done in the back, and bushings are inserted in the upper station. Regardless of the style of adjuster being produced, 150 can be made each hour at 100 per cent efficiency. The accuracy of this machine is obtained by the precise location of the trunnion at each index. The location method is unusual and, though simple, is more accurate than the normal shot-pin. Also, with this method, the cycle-control switch is placed away from possible immersion by the cutting fluid. The trunnion location is obtained by a stop-pin with a cut-out that matches the diameter of four cylindrical index stops. The stop-pin has a central air passage and is moved outward as it passes over an index stop. It is returned to its normal position by a self-contained spring. The outward and return motions of the stop-pin control the motion of a limit switch and, through it, the machine cycle. As the stop-pin rides up and over an index stop, the drive motor is reversed. This causes the trunnion to rotate backwards slightly until the index stop nests in the stop-pin cut-out. When the pin and stop meet, the air passage in the pin is closed. Back pressure thus caused in the airline operates an air cylinder to initiate the " cycle-start " switch.

Because a normal splash lubrication system would produce unwanted heat in the heads, a method of mist lubrication is used within each head. With this self-contained system, little mist escapes to the atmosphere. Simple labyrinth seals at the spindles exclude any coolant. These seals are not the sources of trouble that standard seals for a splash-lubrication system frequently are. In the unusual assembly operation on this trunnion, bushings are fed from a vibrating hopper into three vertical tracks that position them in front of push-rods, in the top station, as shown in the accompanying illustration. They



Bushings are fed along three storage tracks and then picked up by push-rods, positioned, seated and sized within the slack adjusters

are oriented in the hopper by a blade. If the adjuster being made has only one hole, only one push-rod is affixed to the head. Nothing has to be done to the bushing feed mechanism because bushings will not feed into full tracks. Since two different sizes of bushings are used, the hopper and the tracks must be emptied when making a change. The tracks are opened up simply by removing a plate that is held by four thumb-screws.

The tooling comprises four adjustable work-holding fixtures. Workpieces are slipped over horizontal plugs, which accurately locate the large opening in the arm. Two plug sizes are used in several positions to cover the current family of parts. The plugs are moved laterally and keyed to provide a firm foundation for the body of the arm, so tangs can always be clamped in the same plane, regardless of offset. In use, the operator slips a workpiece over the plug and seats the tang against a stationary but adjustable stop. After one-half turn of an actuating handle, the quick-acting wedge-clamp is : (1) rotated to the clamped position ; (2) rapidly pulled in to the part and (3) clamped securely. For the seventeen parts now produced, seven combinations of plug sizes and location are used. If a new design could not be made with these or five other combinations possible with this tooling, it would be easy to make another plug.

Few tool changes are required when changing production from one style to another. Three different diameters of high-speed steel drills—including chamfer cutter and chip-breaker tip—cover the range of hole sizes. Two high-speed steel reamers, including a chamfer cutter and one core drill, complete the cutting tools. Two sizes of piloted push-rods are used to insert the different sizes of bushings into the workpieces.

Modulator With Germanium Diodes for Millimetric Waves

A HIGH-SPEED pulse modulator for millimetre waves was described in Philadelphia recently at the 1960 International Solid State Circuits Conference. The modulator, which uses gold-bonded germanium diodes, was developed by E. T. Harkless and R. Vincent of Bell Telephone Laboratories, to comply with the extremely short rise and fall times and very narrow pulses that are required when utilising pulse code modulation with millimetre waves. With this new modulator, pulse rise and decay times of less than 2 millimicroseconds at a repetition rate of 10 megacycles have been achieved at carrier frequencies of 35 to 52 kilomegacycles per second.

The device switches the incoming r.f. carrier on and off at the desired frequency. It takes advantage of the fact that the r.f. impedance of gold-bonded, n-type germanium diodes, with suitable waveguide mounts and tuning elements, can be varied from a nearly perfect absorber to a practically complete reflector. This change can be effected by merely switching the d.c. bias on the diode. With about 40mA through the diode in the forward direction, it can be made to appear as a matched absorbing load. A reverse bias of 5V to 10V will then cause the assembly to be a nearly perfect reflector.

The modulator uses a pair of diodes mounted in sections of waveguide, combined with a hybrid junction. In the " on " position, the diodes reflect practically all of the incident energy, and the microwave signal is transmitted with an attenuation of only 1 dB to 2 dB. When switched to the " off " position, practically all of the energy incident on the diodes is absorbed, and the transmitted signal is attenuated 30 dB to 40 dB. Up to 1W of power has been successfully modulated at 35 kilomegacycles per second, and pulses as short as 5 millimicroseconds have been used.

The diodes in this assembly are formed inside the waveguide structure, using techniques developed by A. E. Bakanowski, D. E. Iglesias, and Mrs. M. S. Boyle of Bell Laboratories. Essentially they consist of a gold wire attached to an n-type germanium wafer by electrical bonding. The bonding process is carried out by passing three short pulses of current through the contact, giving a small and secure bond area.

Recovery of Watches Bearing Strontium-90

THE U.S. Atomic Energy Commission and the American Rolex Watch Corporation, of New York, are now taking steps to recover a number of Rolex " GMT-Master " wrist watches manufactured by Montres Rolex, S.A., of Geneva. This is a special navigation watch which has a movable rim, or bezel, around the face or dial to permit the wearer to tell time in any two zones of the world at a given moment. The watch may be further identified by the name " Oyster Perpetual " on its face. Action to recover the watches followed the discovery that one Rolex watch of this type, purchased abroad by an American, contained radioactive strontium-90 in the luminescent material on the markings and numerals of the bezel substantially in excess of the amounts exempt from licensing under A.E.C. regulations. During a subsequent check of the firm's inventory, the A.E.C. found several more bezels which contained similar quantities of strontium-90 on the markings and numerals. These quantities are sufficient to present a possible long-term health hazard to the wearer.

The wrist watches were either imported by the company or purchased abroad by individuals. About 600 were imported by the company. The number purchased abroad is believed to be much smaller. Some of the watches imported by the company, still held in stock, were found by A.E.C. inspectors not to contain strontium-90. It is therefore assumed that not all of the wrist watches distributed to the public contain strontium-90. However, it will be necessary to check all such watches to determine whether strontium-90 is present. The extent of the health hazard from a watch similar to those found by the Commission's investigators to contain strontium-90 depends upon the personal habits of the wearer. Although the watches examined vary somewhat in intensity of radiation emitted, the levels of radiation from the backs of the watches are such that, if the watch is worn continuously on the wrist in the normal manner, the skin in contact with the watch might be expected to receive an annual radiation dose in the range from one-half to two times the maximum permissible dose to the hands and forearms recommended for persons whose work involves exposure to radiation, or 75 rems a year. While the probability is considered to be very small that such an exposure from normal wear, even though continued over a period of many years, would result in appreciable damage, such exposures to radiation from a wrist watch should not be permitted. It appears unlikely that an individual would habitually expose a specific portion of the body to the radiation from the face of a wrist watch. Nevertheless, the levels of radiation from the faces of these watches are sufficiently high that several years of more or less continuous exposure of the skin, or several months of exposure of an eye, could produce serious damage.

The company is now attempting to trace the " GMT-Master " wrist watches sold by it in this country. The company has asked its distributors to notify members of the public who purchased these watches in the United States or abroad to return them to its headquarters at 580 Fifth Avenue, New York 36, N.Y., for inspection. If any of the watches are found to contain strontium-90-painted markings and numerals, the parts involved are to be replaced by the company without charge and the watches are to be returned promptly to their owners.

The company has been given a limited licence authorising the receipt of any wrist watches containing strontium-90 returned to it and authorising it to remove any strontium-90-coated parts, under the direct supervision of a representative of the New York Operations Office of the Atomic Energy Commission and to return them to the New York office for disposal.

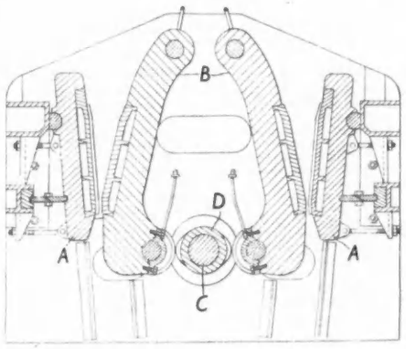
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

STONE BREAKING MACHINES

829,038. January 30, 1958.—STONE BREAKING OR GRANULATING MACHINES, W. H. Baxter, Ltd., 71, Gelderd Road, Leeds, 12 (*Inventor: Edward Nash.*)

In the illustration a stone breaking machine has on each side of its frame means for mounting a pair of fixed jaws *A*. From a pair of parallel pivot



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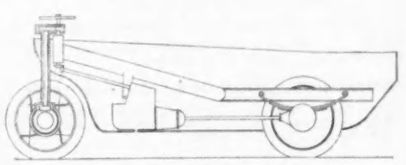
shafts in the upper part of the frame hang a pair of movable jaw stocks *B*. The lower end of each jaw stock is recessed on the rear for the location of a shaft on which is mounted a pair of bearing rollers *C*. Between these two rollers is a cross main shaft mounted in bearings on the frame and driven in any convenient manner. A pair of double-nosed cams *D* on the shaft have an external profile shaped to suit the type of motion it is desired to transmit to the jaw stocks through the rollers. This cam profile can be such as to give an accelerated breaking stroke and more decisive breaking action than hitherto. By the use of a central shaft and operating cams acting simultaneously on opposed jaw stocks forces are equalised to eliminate the possible bending of the shaft and undue wear on its bearings. The machine provides a double breaking action so that if desired slower speeds than a single breaker may be used with an equivalent or increased output.—*February* 24, 1960.

VEHICLES

829,067. April 8, 1958.—AMPHIBIOUS VEHICLES, L'Ispettore Generale, Amministrazione, Militare Italiana-Roma, of Rome, Italy.

The amphibious vehicle illustrated comprises a body supported by a leading wheel on the longitudinal central axis of the vehicle and two rear wheels. The rear wheels are driven, in conventional manner, by an engine which also drives the leading wheel by way of a shaft, bevel and spur gearing. The axle of the wheel is mounted in a housing which can be turned about a vertical axis by a steering wheel or lever through reduction gearing (not shown). The wheel



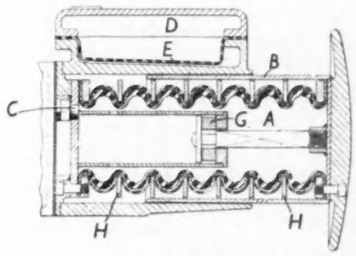
No. 829,067

should be capable of being turned through 270 deg. or more. The spokes of the wheel are shaped as the blades of a screw propeller. The front wheel assembly can thereby serve for propulsion and steering purposes in the water as well as on land. In a modified arrangement instead of making the wheel itself a screw propeller, a drive is transmitted from the axle through bevel gearing and a shaft, to a separate propeller.—*February* 24, 1960.

BUFFERS

828,795. June 6, 1957.—SHOCK ABSORBERS, SPRING SUSPENSIONS AND BUFFING AND DRAUGHT GEAR, George Spencer Moulton and Co., Ltd., Manvers House, Bradford-on-Avon, Wiltshire. (*Inventors: Alexander Eric Moulton and John Murray Chrystal.*)

Referring to the drawings the buffer has a corrugated hose forming the bellows *A* which is provided



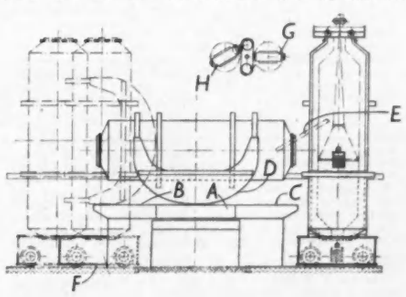
No. 828,795

at each end with annular flanges sealing it to a buffer head and the inner end of the buffer casing. The buffer head is carried by a cylindrical sleeve *B* telescopically mounted in the buffer casing. *C* is a constant leak valve in the rear wall of the buffer casing, through which the fluid is forced into the recuperating chamber *D* situated on top of the buffer casing. The recuperating chamber has a diaphragm *E* which isolates air in the upper part of the chamber from the fluid below. For limiting outward movement of the buffer head, a recoil central rod extends rearwardly from the buffer head into an auxiliary cylinder on the rear wall. An annular rubber compression spring *G* prevents metal-to-metal contact and cushions the final movement on recoil. The bellows comprises an inner portion of oil-resistant rubber with an embedded fabric reinforcement sleeve and an outer sheath of rubber. Metal hoops, *H*, located in each depression between the successive corrugations constitute a guide for the corrugated hose during the telescoping movement of the sleeve along the casing.—*February* 24, 1960.

FURNACES

828,952. May 28, 1957.—ROTARY TILTING FURNACE PLANT, Demag Aktiengesellschaft, Wolfgang-Reuter-Platz, Duisburg, Germany.

The invention relates to plant incorporating tiltable furnaces which are rotatable about their longitudinal axes, and which may be used either as melting furnaces, reduction furnaces, or for refining or fining processes. A rolling track *A* on a base has two extensions *B* and *C*, and on



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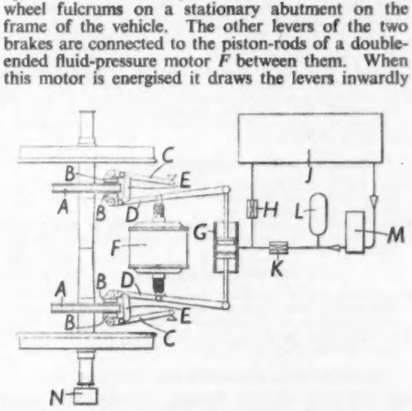
the track a tilting or rolling rocker *D* is movable. The rocker carries the rotary drum furnace mounted on bearing rings. If the furnace operates to refine or purify a metal, then air or oxygen is injected through one or more lances *E*. By rolling the rocker *D* on the track to extension *C* the furnace drum may be brought into the vertical position. At one or both ends of the track are provided rails over which run heavy carriages *F* which take over the furnace drum when it is in the vertical position. The carriage moves the furnace drum out of the area to a position where the furnace drum can be relined. The empty tilting rocker is then either tilted to the full extent in the opposite direction, or turned together with the track about a horizontal axis, as indicated, until it is in the receiving position for a relined furnace drum on the other side at *C*. In the furnace plant constructed according to the inset drawing, two pivotable rotary furnace drums, *G*, *H*, are illustrated in plan. Between the two furnaces is provided a transfer device in the form of a rotary platform. During operation there is always a relief furnace drum on a transfer device, while the other two furnace drums are in operation. The substitution of the used furnace drum by relined drums is first effected with the right-hand furnace drum *G* and then drum *H*, so that the installation requires only three furnace drums with which a practically uninterrupted operation may be maintained.—*February* 24, 1960.

RAILWAY BRAKES

828,873. July 16, 1958.—BRAKING SYSTEMS FOR VEHICLES, Girling, Ltd., Kings Road, Tyseley, Birmingham, 11. (*Inventor: Geoffrey Carl Jackson.*)

One practical braking system for a rail vehicle is illustrated diagrammatically in the accompanying drawing. Brake discs *A* are mounted on the axle inboard of the wheels and opposite faces of each disc are engaged by friction pads *B* on shoes pivotally mounted in the inner ends of caliper levers *C*, *D*. The caliper levers are connected by a transverse link *E*, and the lever *C* nearest the wheel fulcrums on a stationary abutment on the frame of the vehicle. The other levers of the two brakes are connected to the piston-rods of a double-ended fluid-pressure motor *F* between them. When this motor is energised it draws the levers inwardly



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to apply the brakes. The levers *D* are extended, and their outer ends are pivotally connected to the piston-rods of a second double-ended fluid-pressure motor *G* which urges the levers apart to reduce the braking effort when fluid is admitted between the pistons. The space between the pistons in cylinder *G* is connected by a pipeline through a first valve *H* to a reservoir *J*. It is also connected through a second valve *K* to an accumulator *L* which is connected through a non-return valve to an intensifier *M*. The intensifier is connected through a second non-return valve to the reservoir. The valves *H* and *K* are controlled through any convenient relay mechanism by a deceleration-conscious device, *N*, driven by the axle. The valve *H* is normally open and the other valve *K* is closed so that the second fluid-pressure motor is connected to the reservoir and is cut off from the accumulator. When the brake has been applied by energisation of the motor *F* and the rate of retardation of the axle exceeds a predetermined value the device *N* causes the closing of the valve *H* and the opening of the valve *K* so that fluid under high pressure from the accumulator is admitted to the motor *G* which opposes the braking force and so reduces the retardation of the axle. As soon as the rate of retardation has been reduced below the predetermined maximum the device *N* returns to its normal condition and the valve *K* closes and the valve *H* opens so that the pressure in the motor *G* is relieved and normal braking is resumed. The rate at which the pressure in the second motor is relieved can be controlled by the rate of flow through the valve *H*.—*February* 24, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ANTIQUARIAN HOROLOGICAL SOCIETY

To-day, March 18.—Science Museum, South Kensington, London, S.W.7, Discussion on the work of the Ellicotts, 7 p.m.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, March 18.—STOKE AND CREWE BRANCH : Royal Hotel, Crewe, "Modern Trends in Industrial and Commercial Lighting Installations," V. Heydon, 7.30 p.m.
Tues., March 22.—ALDERSHOT AND DISTRICTS BRANCH : Prince of Wales Hotel, Woodbridge Road, Guildford, "Electrical Hazards at Home," S. J. Emerson, 7.30 p.m. ★ EAST KENT BRANCH : Clarendon Hotel, Broadstairs, "The National Inspection Council and its Effect on the Electrical Contracting Industry," E. J. Sutton, 8 p.m.
Thurs., March 24.—SOUTHAMPTON BRANCH : Polygon Hotel, Southampton, "Floor Warming and Space Heating," D. W. Ackery, 8 p.m. ★ SOUTH LONDON BRANCH : Greyhound Hotel, High Street, Croydon, Surrey, "Meters and Metering," 8 p.m.
Fri., March 25.—COVENTRY AND DISTRICT BRANCH : E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, "Modern Light Sources," W. A. R. Stoyle, 7.45 p.m.

BRITISH COMPUTER SOCIETY

Thurs., March 24.—SOUTH WALES AND MONMOUTHSHIRE BRANCH : Small Shandon Lecture Theatre, University College, Cardiff, "Interesting Cases of Linear Programming," C. M. Berners-Lee, 6.30 p.m.

BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION

Mon., March 21.—Royal Commonwealth Society Hall, Craven Street, London, Caroline Haslett Memorial Trust Lecture, Miss Kay E. Pennett, 6 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Wed., March 23.—STUDENTS' AND GRADUATES' SECTION OF THE LONDON BRANCH : Wellcome Foundation Hall, 183, Euston Road, London, N.W.1, Annual Open Meeting, "The Good Manager," T. T. Paterson, 7 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., March 24.—MEDICAL ELECTRONICS GROUP : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "The Continuous Recording of Heart Activity," I. Boyd and W. R. Eadie, 6.30 p.m. ★ SCOTTISH SECTION : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Radio Guidance in the Automatic Landing of Aircraft," J. Shayler, 7 p.m.
Fri., March 25.—SCOTTISH SECTION : Department of Natural Philosophy, The University, Drummond Street, Edinburgh, "Radio Guidance in the Automatic Landing of Aircraft," J. Shayler, 7 p.m.

CEMENT AND CONCRETE ASSOCIATION

Tues., March 22.—Technical College, Mold Road, Wrexham, "Leadership and Management in the Building Industry," Sir Robert O. Lloyd, 7 p.m.
Wed., March 23.—Derby and District College of Art, Green Lane, Derby, "Work Study in the Building Industry," K. C. Symons, 7.15 p.m.

CHEMICAL SOCIETY

Thurs., March 24.—Chemistry Lecture Theatre, The University, Manchester, Joint meeting with the Institute of Petroleum, Royal Institute of Chemistry and the Society of Chemical Industry, Symposium on "The Industrial Chemistry of the Lower Olefines," 10.30 a.m., 2.30 p.m. and 5 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., March 22.—SCOTTISH REGION : Grand Hotel, Charing Cross, Glasgow, Discussion on "The Industrial Use of Gas," opened by R. W. Deans, 10.30 a.m.; Discussion on "Problems of the Packaged Boiler," opened by A. Wilson, 2 p.m.
Thurs., March 24.—WESTERN REGION : Seabank Hotel, Porthcawl, Glamorgan, "Modern Industrial Water Treatment," G. Ferencz, 11 a.m.; "The Training of Boiler House Operatives by N.I.F.E.S.," 2.15 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., March 21.—LEEDS CENTRE : British Lighting Council, 24, Aire Street, Leeds, 1, A Survey of "Lighting in Corrosive, Flammable and Explosive Situations," introduced by J. G. Holmes, 6.15 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Mon., March 21.—BEDS AND HERTS SECTION : Britannia Iron and Steel Works, Ltd., Bedford, "Automatic Moulding and Pouring Plant," C. Zehnder, 7.30 p.m.
Wed., March 23.—Constitutional Club, Northumberland Avenue, London, W.C.2, "Review of the Work of the I.B.F. Technical Council on the Effect of Cooling Rate on the Properties of Grey-iron Castings," M. M. Hallett, 7.30 p.m. ★ SOUTHAMPTON SECTION : Technical College, St. Mary's Street, Southampton, "The Buehrer Automatic Moulding Plant," G. Zehnder, 7.30 p.m.

INSTITUTE OF FUEL

Tues., March 22.—SCOTTISH SECTION : Royal College of Science and Technology, Glasgow, Annual General Meeting, 6 p.m., and "Electro-Precipitators," J. Martin and J. E. Sayers, 7 p.m.
Wed. March 23.—REPUBLIC OF IRELAND GROUP : Engineers' Hall, 35, Dawson Street, Dublin, "Drum and Pneumatic Driers," H. Pollock, 8 p.m. ★ LONDON BRANCH : Institution of Civil Engineers, Great George Street, London, S.W.1, "A New Process for Briquetting Coal without a Binder," H. R. Gregory, 5.30 p.m.
Thurs., March 24.—EAST MIDLAND SECTION : Electricity Showrooms Lecture Theatre, Nottingham, "First Principles of Work Study," J. McLean, 6.30 p.m. ★ MIDLAND SECTION : John Thompson Lecture Hall, Ettingshall, Wolverhampton, "Waste Heat Recovery," G. H. Steward, 6.30 p.m.

INSTITUTE OF NAVIGATION

To-day, March 18.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The American Air Traffic Control Programme," Hans Giesecke, 5.15 p.m.

INSTITUTE OF PETROLEUM

Tues., March 22.—LONDON BRANCH : 61, New Cavendish Street, London, W.1, "Technical Education in Russia," H. Levy, 6 p.m.

INSTITUTE OF WELDING

Wed., March 23.—MEDWAY SECTION : Sun Hotel, Chatham, Kent, "Developments in Automatic Welding," A. M. Horsfield, 7.30 p.m.

INSTITUTION OF AGRICULTURAL ENGINEERS

Wed., March 23.—EAST MIDLANDS CENTRE : N.F.U. Offices, Park Street, Lincoln, "Aircraft in Agriculture," 7.30 p.m.
Fri., March 25.—WEST MIDLANDS CENTRE : Hotel Leofric, Coventry, Annual General Meeting, 6.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., March 22.—LONDON BRANCH : Geological Society, Burlington House, London, W.1, "The Flow of Granules through Apertures," R. L. Brown, 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 22.—Great George Street, Westminster, London, S.W.1, James Forrest Lecture, "Plastics in Engineering," R. Beeching, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, March 18.—LONDON GRADUATE AND STUDENT SECTION : Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Annual Joint Meeting. Address by Sir George Edwards, 6.30 p.m.
Mon., March 21.—LONDON GRADUATE AND STUDENT SECTION : Savoy Place, London, W.C.2, "Developments in Lighting," F. A. Benson, 6.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION—ARBORFIELD DISTRICT : Assembly Hall, 3 (Tels.) Training Bn., R.E.M.E., Arborfield, Berks, "Inertial Navigation Systems," E. W. Anderson, 7 p.m. ★ NORTH-EASTERN CENTRE : Neville Hall, Westgate Road, Newcastle upon Tyne, "The Shielding of Overhead Lines against Lightning," J. H. Gridley, 6.15 p.m. ★ SHEFFIELD SUB-CENTRE : Angel Hotel, Brigg, "Education for Electrical Engineering with Particular Reference to the New I.E.E. Regulations," G. W. Carter, 7 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE : Technical College, Stafford, Joint meeting with the Graduate and Student Section, Short Papers Evening, 7 p.m. ★ WESTERN SUPPLY GROUP : South Wales Institute of Engineers, Park Place, Cardiff, "Construction Problems," R. Lefevre, 6 p.m.
Tues., March 22.—NORTH-WESTERN MEASUREMENT AND CONTROL GROUP : Engineers' Club, Albert Square, Manchester, Discussion on "Electrical Railway Signalling and Control," "Coloured Light Signalling," G. I. Foster, and "Automatic Control in Marshalling Yards," R. N. Foulkes, 6.15 p.m.
Wed., March 23.—ELECTRONICS AND COMMUNICATIONS SECTION : Savoy Place, London, W.C.2, "The Challenge of the Propagation Medium to the Radio Engineer" G. Millington, 5.30 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Logmotor—A Cylindrical Brushless Variable Speed Induction Motor," F. C. Williams, E. R. Laithwaite, J. F. Eastham and L. S. Piggott, 6 p.m. ★ SOUTHERN CENTRE : Plessey's Works, Romsey, Hants, Joint meeting with the Graduate and Student Section, "Electrical Phenomena at Very Low Temperature," R. E. Hayes, 6.30 p.m.
Thurs., March 24.—EAST MIDLAND CENTRE : E.M.E.B. Service Centre, Spalding, "Space Heating," D. H. Parry, 7.30 p.m.
Fri., March 25.—NORTH EASTERN GRADUATE AND STUDENT SECTION : Grey Hall, King's College, Newcastle upon Tyne, "Reactor Instrumentation," R. G. Gold, 6.30 p.m.
Sat., March 26.—LONDON GRADUATE AND STUDENT SECTION : Visit to Tower Bridge (Bridge Operating Mechanism), 3 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., March 29.—39, Elmbank Crescent, Glasgow, "The Design of Ships' Interiors," M. Black, and K. Bayes, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, March 18.—N.E. BRANCH : University Science Laboratories, Durham, "Mining Subsidence with special reference to Highways," R. J. Orchard, Annual General Meeting, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Mon., March 21.—DERBY A.D. CENTRE : Railway Staff Training College, London Road, Derby, "Railway Traction : the Successors to the Steam Locomotive," L. F. R. Fell and K. Tyler, 7.15 p.m. ★ SCOTTISH A.D. CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, Crompton-Lanchester Lecture, "Automobile Lubrication and Lubricants," A. Towle, 7.30 p.m.
Mon. and Tues., March 21 *and* 22.—INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "The Computer in Production," 10 a.m.
Tues., March 22.—NORTH WESTERN BRANCH—LIVERPOOL PANEL : Blossoms Hotel, Chester, "The Vibration of Vertical Milling Machines under Test and Working Conditions," S. A. Tobias, 6.45 p.m. ★ BIRMINGHAM A.D. CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, "Cold Starting Phenomena in Diesel Engines," A. E. W. Austen and W. T. Lyn, 6.30 p.m. ★ LONDON GRADUATES' SECTION : 1, Birdcage Walk, Westminster, London, S.W.1, "Maintenance of Oil Refinery Plant and Equipment," P. S. Campbell, 6.30 p.m.
Wed., March 23.—EASTERN GRADUATES' SECTION : Visit to the Wellingborough Iron Company, 7.30 p.m. ★ LONDON GRADUATES' SECTION : Visit to Sun Printers, Ltd., Watford, 7.30 p.m. ★ SOUTHERN GRADUATES' SECTION : Cockcroft Hall, Harwell, "Brush Plating," Mr. Hughes, 3.15 p.m.
Thurs., March 24.—APPLIED MECHANICS GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "A Replica Technique for Measuring Static Strains," introduced by V. M. Hickson, 6 p.m. ★ EASTERN BRANCH : Hoffman Hall, Chelmsford, "The Application of High-powered Epicyclic Gearing for Industrial and Marine Uses," H. N. G. Allen and T. P. Jones ; Colour film, "For Mechanical Advantage," 7.30 p.m. ★ NORTH WESTERN BRANCH : Engineers' Club, Albert Square, Manchester, 2, "The Direct Conversion of Heat to Electricity," Dr. Dunn, 6.45 p.m. ★ SOUTHERN BRANCH : Visit to Telegraph Construction and Maintenance Company, Ltd., Metals Division, Telcon Works, Manor Royal, Crawley, 2.30 p.m. ; Crawley College of Further Education, College Road, Crawley, Repetition of the Thomas Hawksley Lecture, "The Effect of Nuclear Radiation on Engineering Materials," A. H. Cottrell, 6.15 p.m. ★ YORKSHIRE BRANCH : Percival Whitby College of Further Education, Halifax, "The Mechanics of Orthogonal Machining," W. B. Palmer and L. P. B. Oxley, 7.15 p.m. ★ EAST MIDLANDS GRADUATES' SECTION : Room C4, Engineering Building, The University, Nottingham, Joint meeting with the local Students' and Graduates' Section of the Institution of Civil Engineers, "Vibrations of Stiffened Plates," C. L. Kirk, 7.15 p.m. ★ SCOTTISH GRADUATES' SECTION : The Engineering Building, The University, Glasgow, W.2, "Engineering Problems in Nuclear Power Stations," K. J. Wootton, 7.30 p.m.

INSTITUTION OF PLANT ENGINEERS

To-day, March 18.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, Annual General Meeting followed by a film, 7.30 p.m.
Mon., March 21.—WEST AND EAST YORKSHIRE BRANCH : Houldsworth School of Applied Science, The University, Leeds, Annual General Meeting, 7.30 p.m.
Tues., March 22.—WESTERN BRANCH : Grand Hotel, Broad Street, Bristol, Annual General Meeting, 7.15 p.m.
Wed., March 23.—LEICESTER BRANCH : Bell Hotel, Leicester, Members' Evening, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., March 21.—NORTH MIDLANDS REGION : Louis Room, St. James's Restaurant, St. James's Street, Derby, Annual General Meeting, and Film Show, 7 p.m. ★ NORTH WESTERN REGION : Grand Hotel, Hanley, Stoke-on-Trent, Annual General Meeting and "Tool Wear and Machinability," E. M. Trent, 7 p.m.
Wed., March 23.—NORTH WESTERN REGION : Exchange Hotel, Tithebarn Street, Liverpool, 1, Annual General Meeting and Film Show, 7.30 p.m. ★ MANCHESTER GRADUATE SECTION : Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester, Annual General Meeting ; and "The Work of the Consumer Research Association," J. Thirwell, 7.15 p.m.
Thurs., March 24.—LIVERPOOL GRADUATE SECTION : Lecture Hall, Y.M.C.A., Mount Pleasant, Liverpool, Annual General Meeting ; Film Show, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, March 18.—LANCASHIRE AND CHESHIRE BRANCH : College of Science and Technology, Manchester, "The Design and Construction of the Exhibition Palace of the National Centre of Industries and Technology, Paris," D. D. Mathews, 6.30 p.m. ★ N. COUNTIES BRANCH : Neville Hall, Newcastle, "The Modernisation of British Waterways with particular reference to the South Eastern Division," J. H. H. Gillespie, 6.30 p.m.
Wed., March 23.—YORKSHIRE BRANCH : Electricity Building, Ferensway, Hull, "The Bearing Capacity of Driven Piles," F. R. Bullen, 6.15 p.m.
Thurs., March 24.—LONDON BRANCH : 11, Upper Belgrave Street, London, S.W.1, "Research for the Concrete Industry," A. R. Collins, 6 p.m.
Fri., March 25.—MIDLAND COUNTIES BRANCH : James Watt Memorial Institute, Birmingham, "The Structural Use of Prestressed Concrete in Buildings C.P. 115," A. W. Hill, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 18.—INFORMAL MEETING : Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Application, Uses, and Limitations of Modern Plastics Materials in Engineering," J. M. J. Estevez, 7 p.m.
Mon., March 21.—SHEFFIELD SECTION : Royal Victoria Hotel, Sheffield, Visit of the President, J. M. Kay, and Presidential Address, "The Engineer's Role in Nuclear Power," 7.30 p.m.
Tues., March 22.—NORTH WESTERN SECTION : Engineers' Club, Albert Square, Manchester, Visit of the President, J. M. Kay, and Presidential Address, "The Engineer's Role in Nuclear Power," 7 p.m.
Fri., March 25.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Application of Dimensional Tolerances," R. J. Herbert, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., March 25.—Engineers' Club, Albert Square, Manchester, 2, Annual General Meeting ; and "The Design and the Erection of the Atomium," F. Hebrant, 6.45 p.m.

N.E. COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., March 25.—Lecture Theatre, Mining Institute, Neville Hall, Newcastle upon Tyne, "Manufacture of Doxford Crankshafts," R. Atkinson, 6.15 p.m.

PLASTICS INSTITUTE

To-day, March 18.—MIDLANDS SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Silicones in the Plastics and Rubber Industries," P. A. J. Gate, 6.30 p.m.
Wed., March 23.—WESTERN SECTION : Royal York House Hotel, Bath, "The Manufacture of General Purpose Styrene Butadiene Rubber and its Aspects in the Chemical Engineering Field," R. Jackson, 7 p.m.

REINFORCED CONCRETE ASSOCIATION

Thurs., March 24.—WEST OF ENGLAND BRANCH : New School of Engineering, The University, Bristol, Annual Meeting and Films, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

To-day, March 18.—AGRICULTURAL AVIATION GROUP : Library, 4, Hamilton Place, London, W.1, Film Evening, 7 p.m.
Thurs., March 24.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Engines for Supersonic Air Liners," R. R. Jamison, and R. J. Lane, 6 p.m.
Fri., March 25.—MAN-POWERED AIRCRAFT GROUP : Library, 4, Hamilton Place, London, W.1, "Aerodynamics of Man-Powered Flight, with Special Reference to Inflatable Wings," D. Perkins, 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN

To-day, March 18.—21, Albemarle Street, London, W.1, "Infra-Red Radiation," R. V. Jones, 9 p.m.

ROYAL INSTITUTION OF NAVAL ARCHITECTS

Tues. to Thurs., March 22 *to* 24.—Weir Lecture Hall, 10, Upper Belgrave Street, London, S.W.1, Spring Meeting, 1960, 10.15 a.m. and 2.30 p.m. each day.

ROYAL SOCIETY OF ARTS

Wed., March 23.—John Adam Street, Adelphi, London, S.W.1, "Modern Trends in Industrial Design," Sir Gordon Russell, 2.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, March 18.—39, Elmbank Crescent, Glasgow, "Technical Factors in the Production of Iron by Methods other than the Blast Furnace," J. Taylor, 6.45 p.m.

WILLESDEN AND HENDON PRODUCTIVITY COMMITTEE AND INSTITUTE OF MATERIALS HANDLING

Tues. and Wed., March 22 *and* 23.—Technical College, Denzil Road, Willesden, London, N.W.10, Two-day conference on "Materials Handling," 10 a.m.

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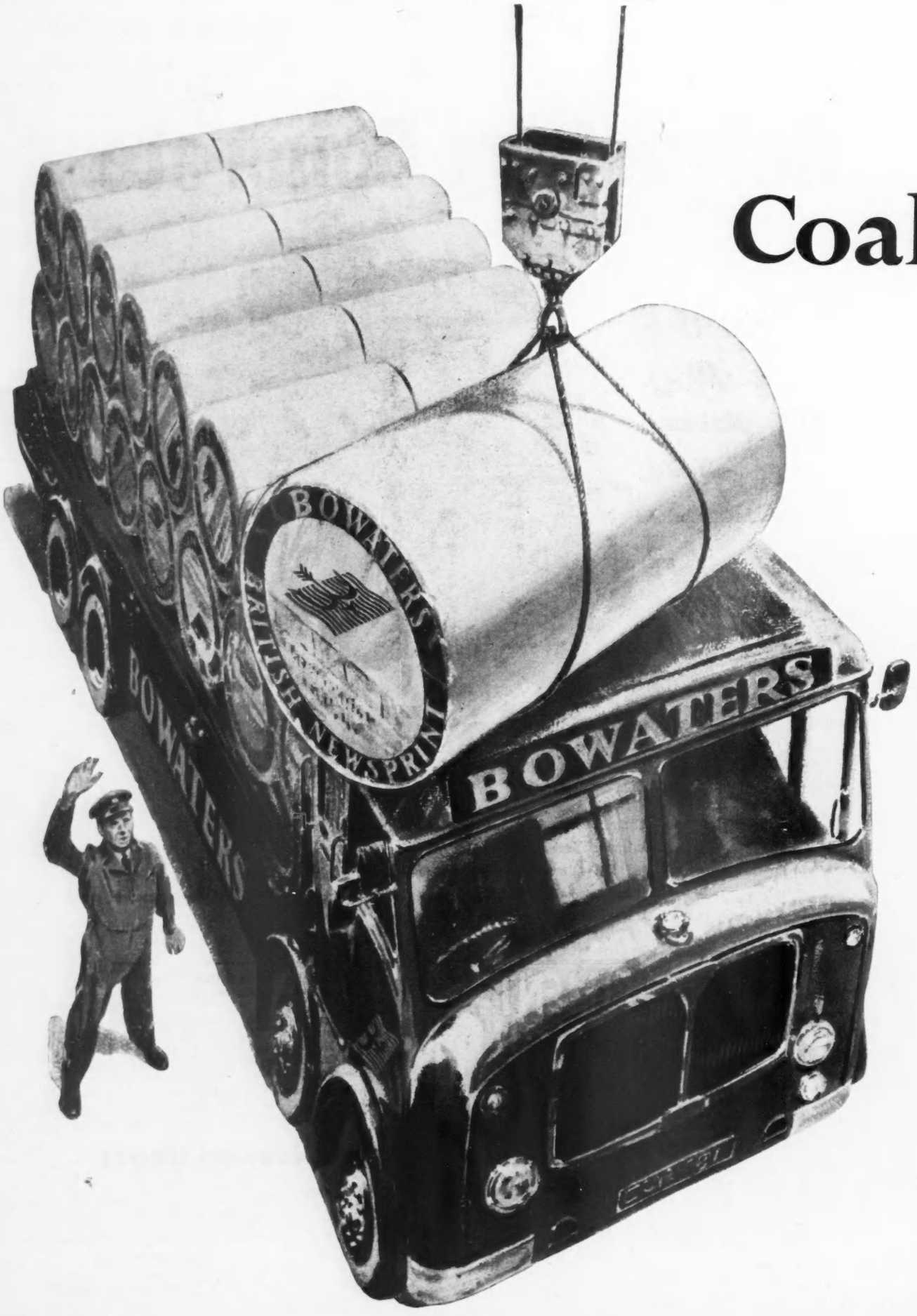

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THE MEN AT BOWATERS who run their international organisation producing paper, board and packaging of all kinds have a precise knowledge of all that goes to make their top quality products. That is why they chose coal to run the powerhouses that begin the process of paper-making at their great mills in the United Kingdom.

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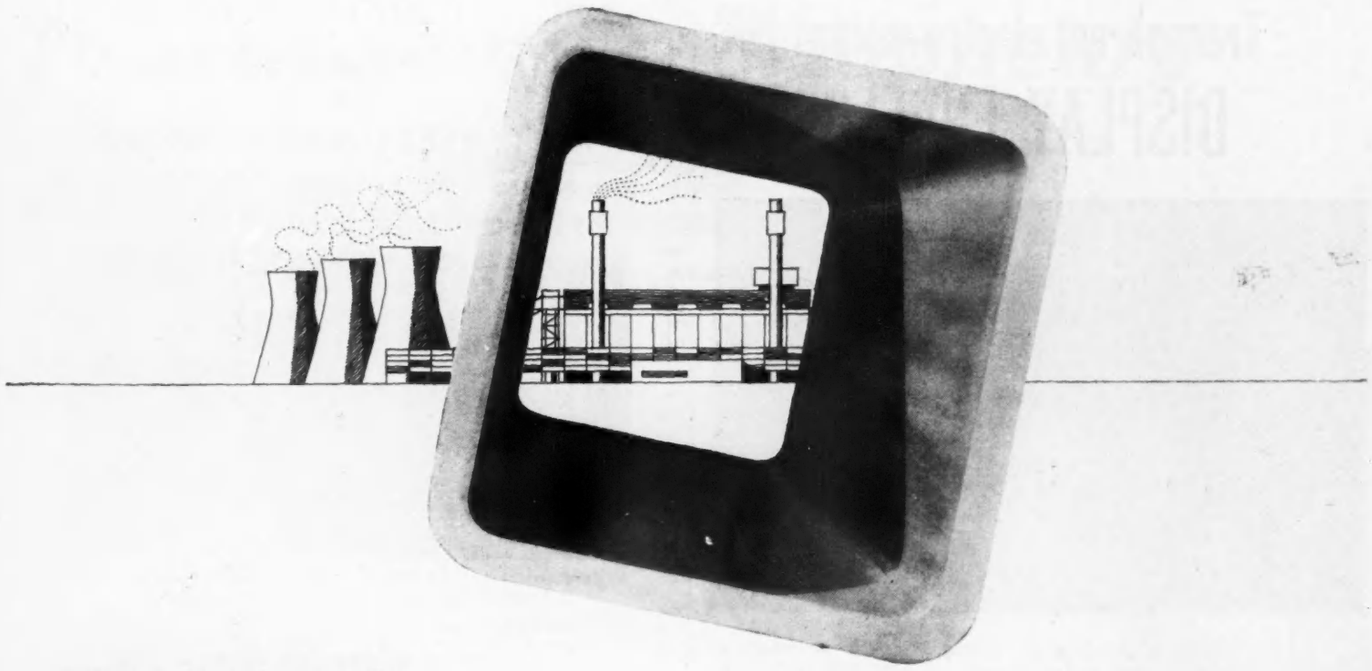

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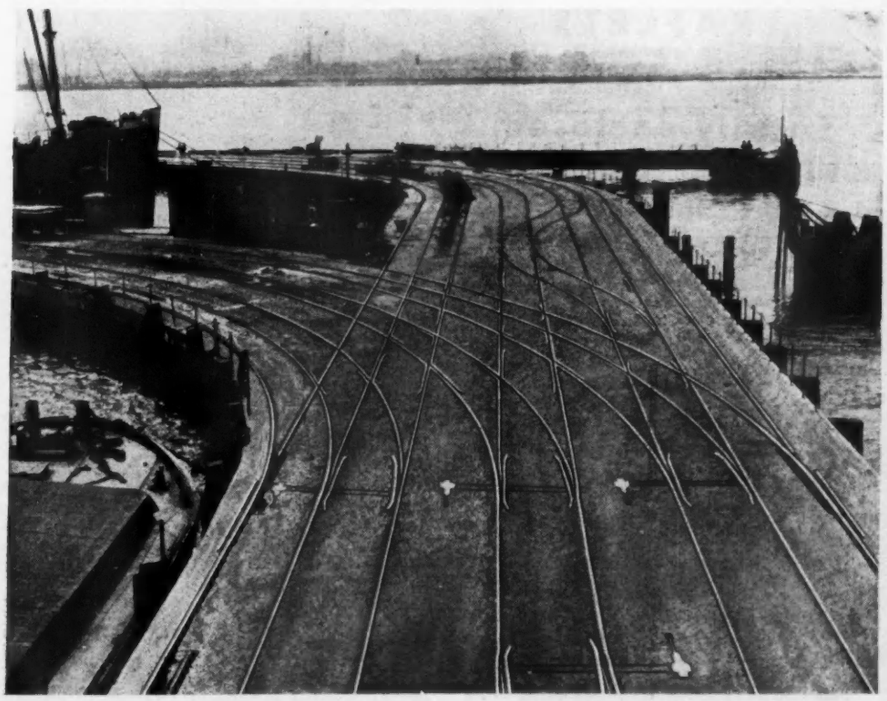

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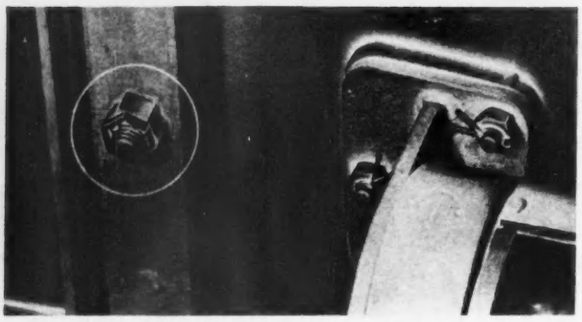

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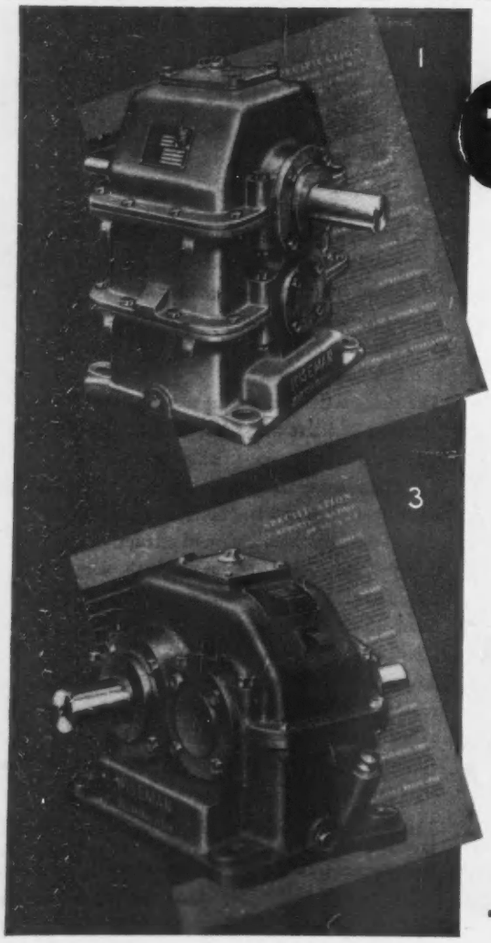

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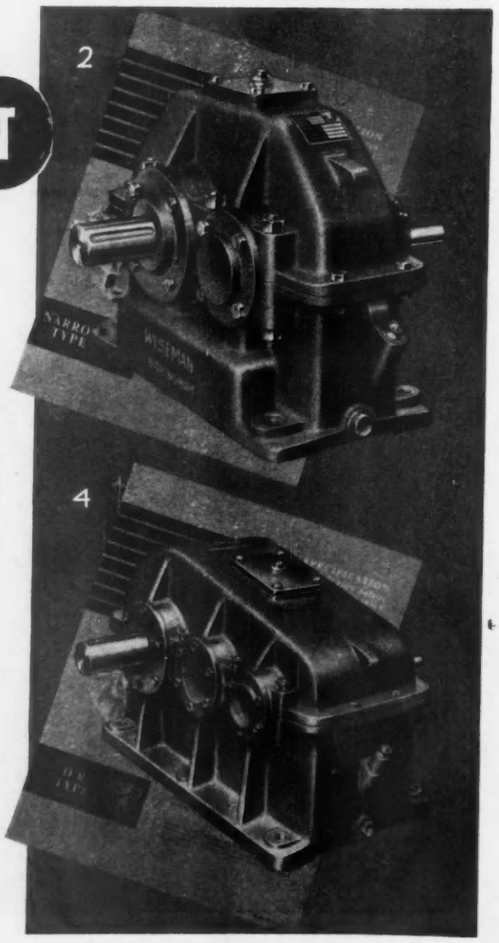

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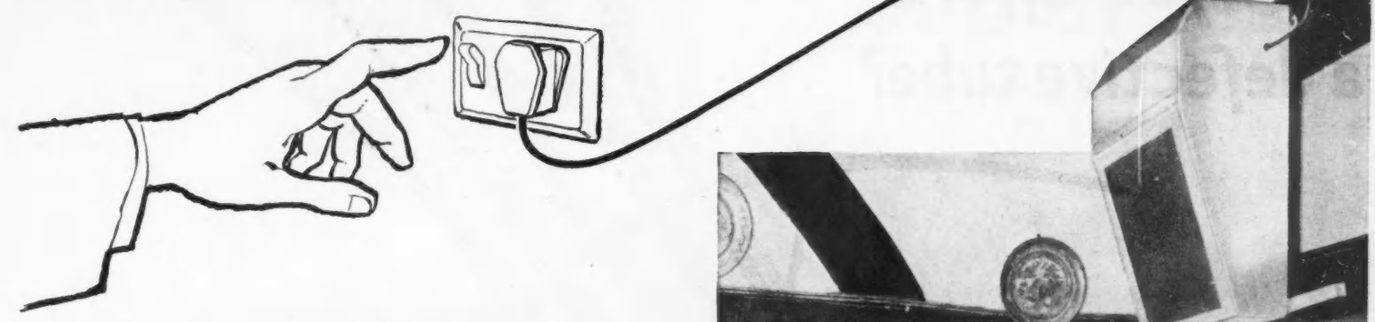

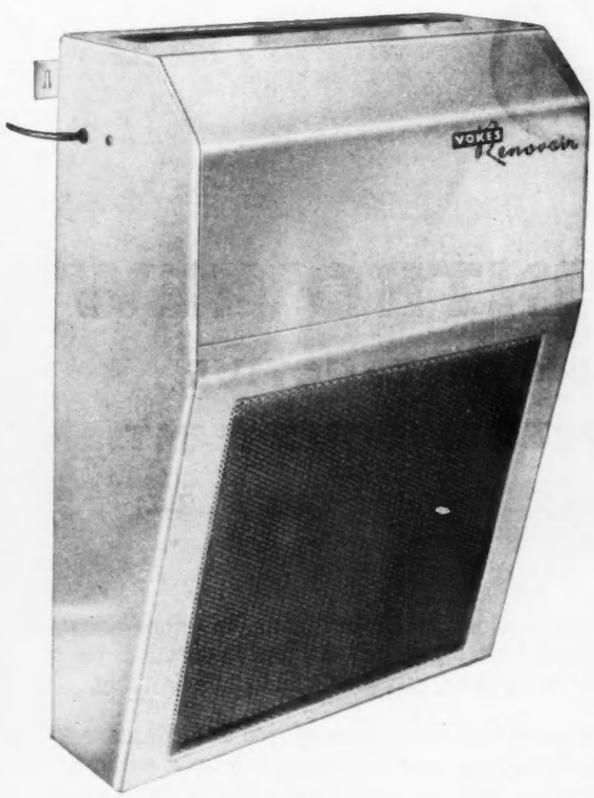

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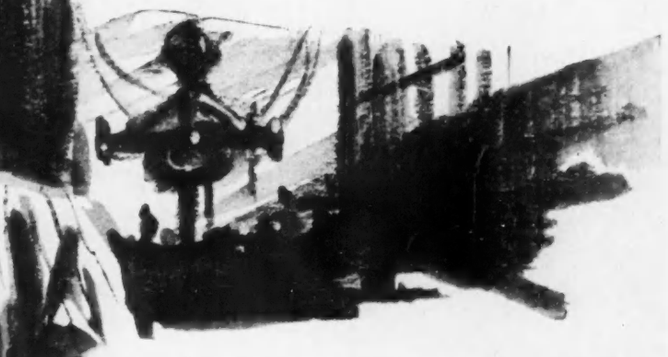

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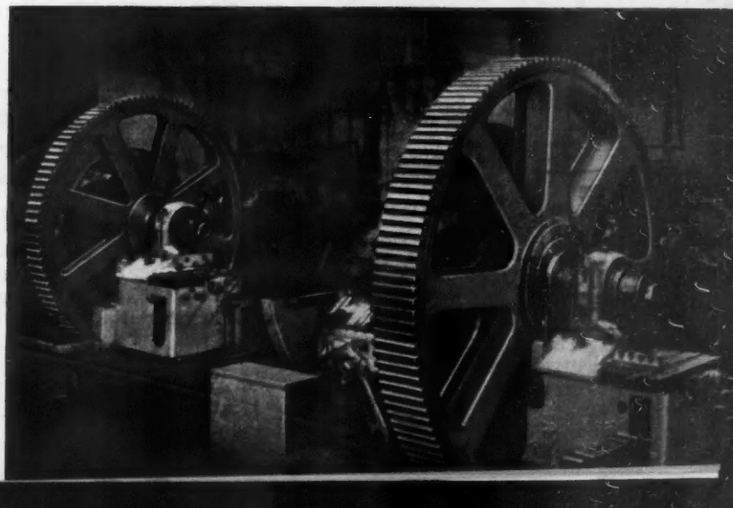

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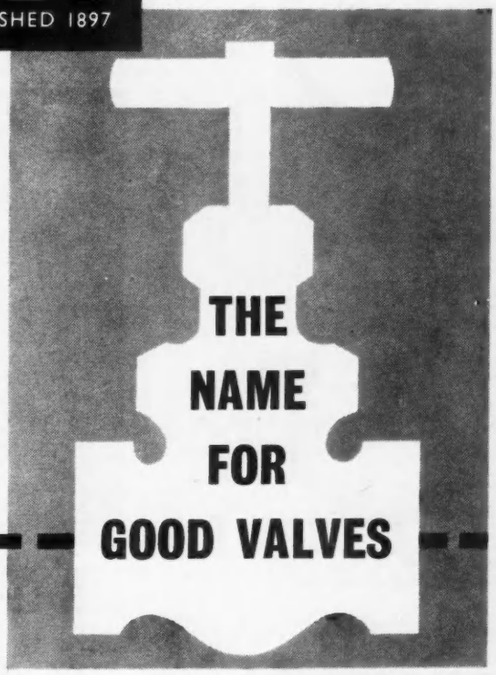

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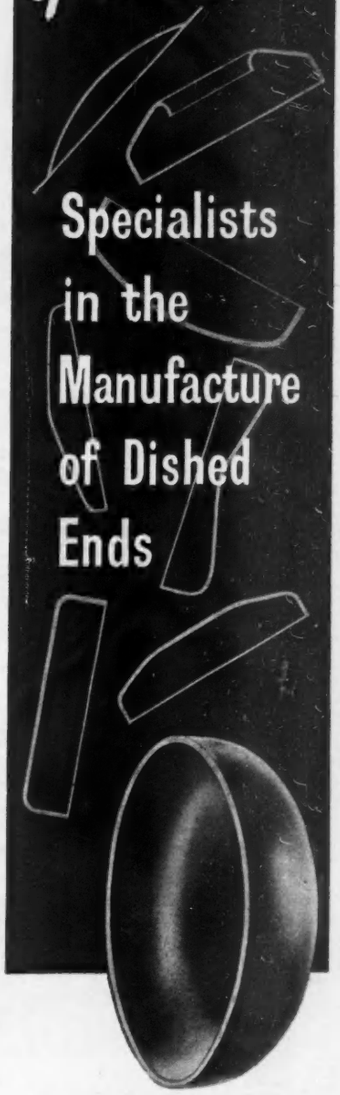

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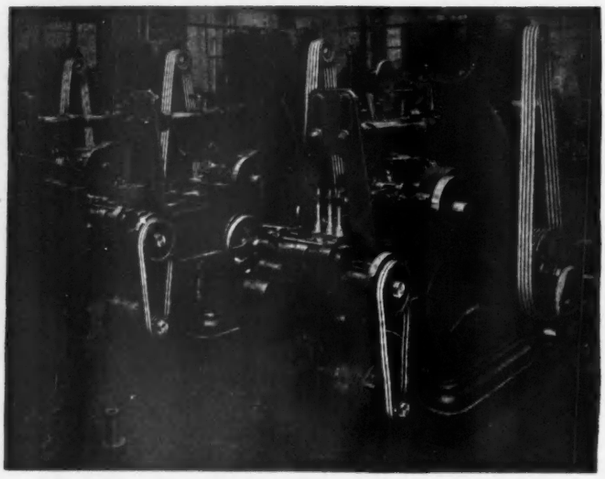

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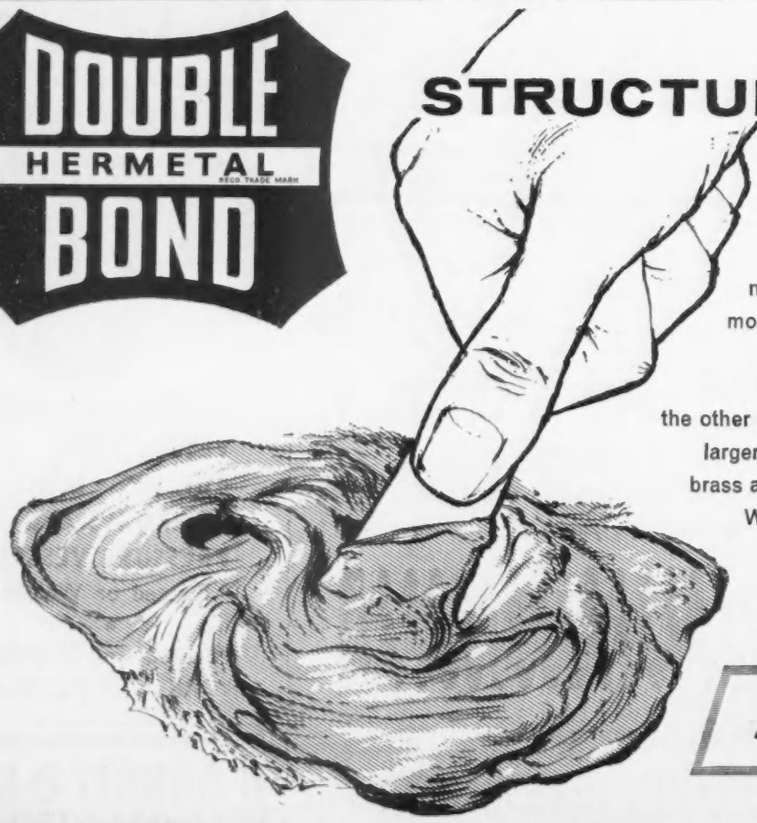

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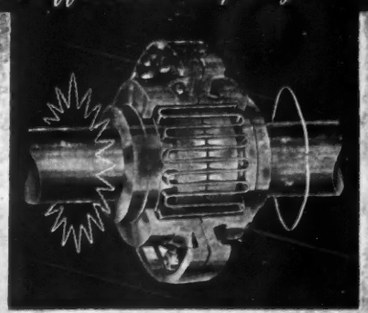

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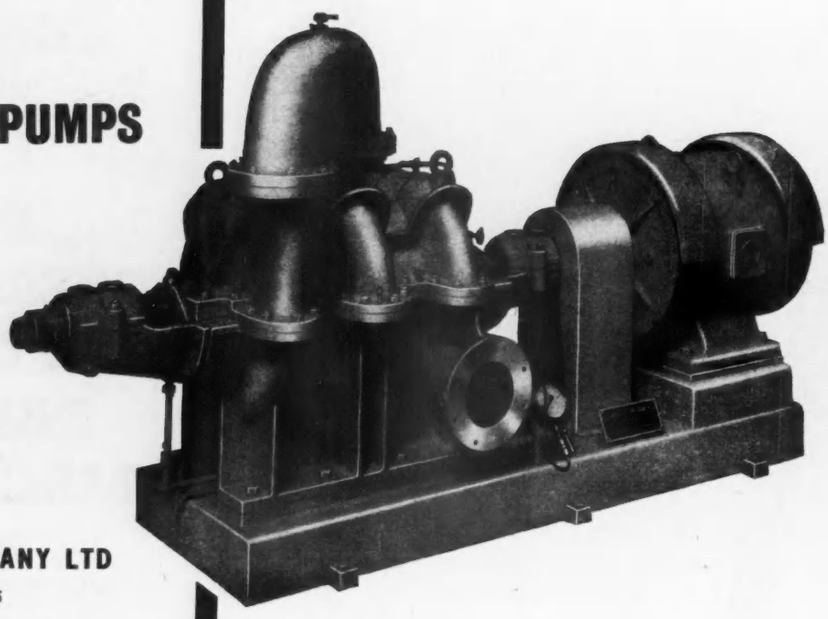

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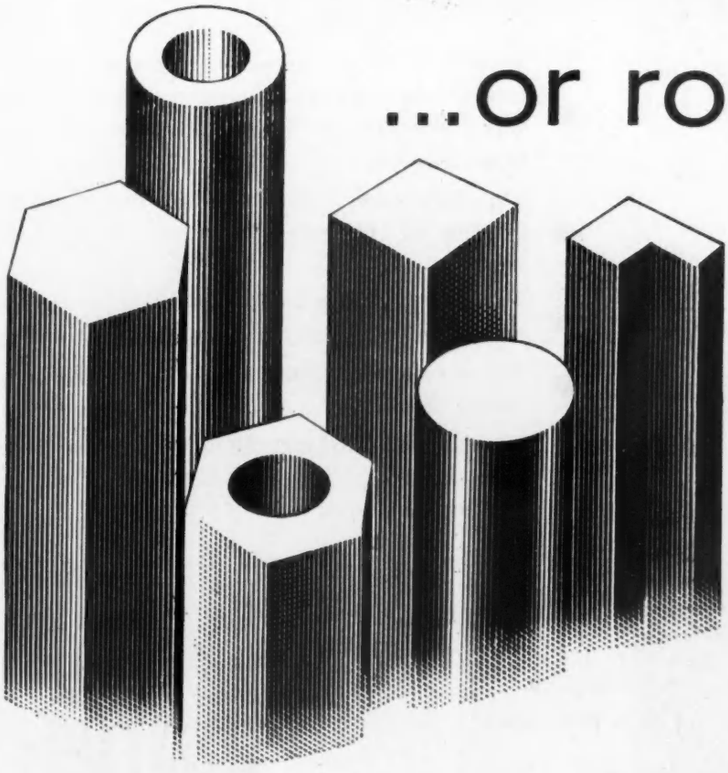

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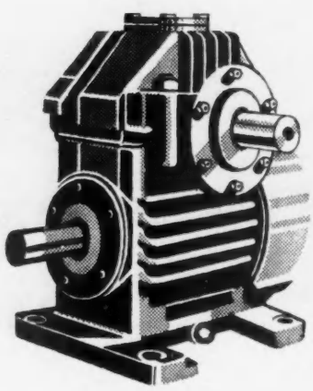

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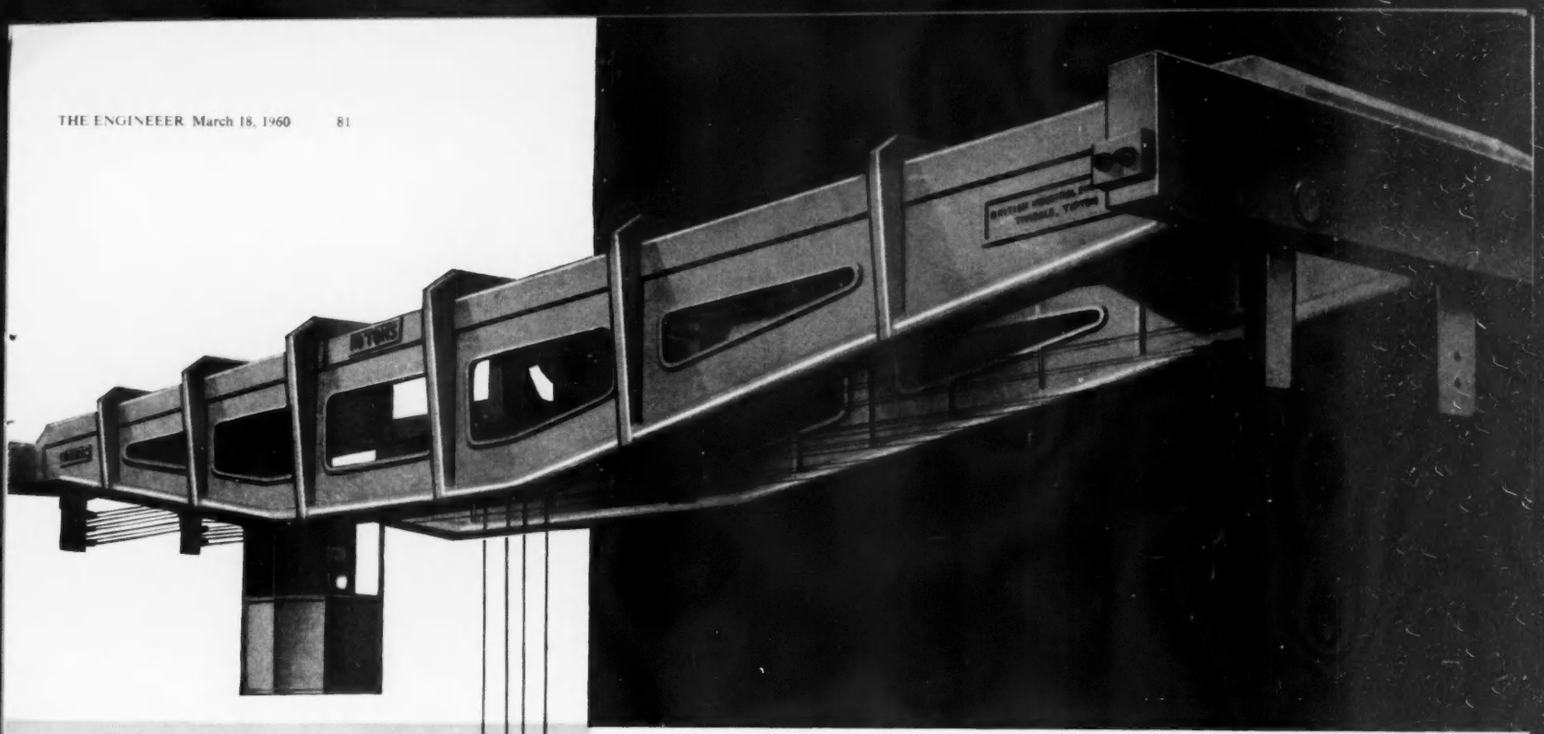

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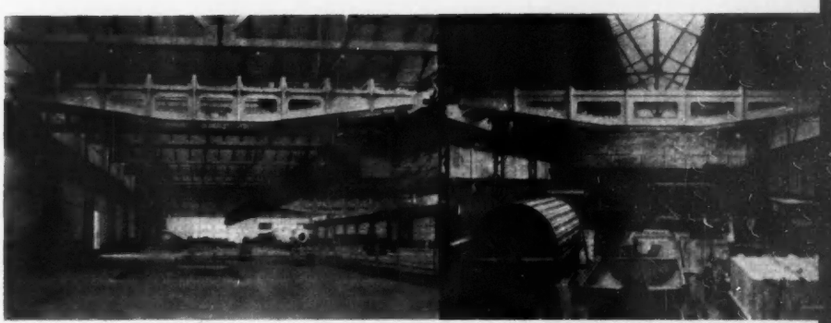

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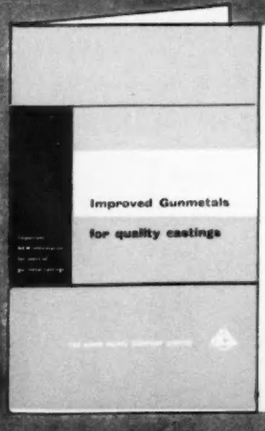

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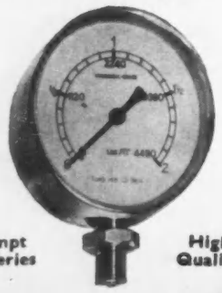

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It puts into condensed form a mass of facts on the best type of Meehanite for given service conditions. It is based on 25 years' experience of Meehanite castings in industry.

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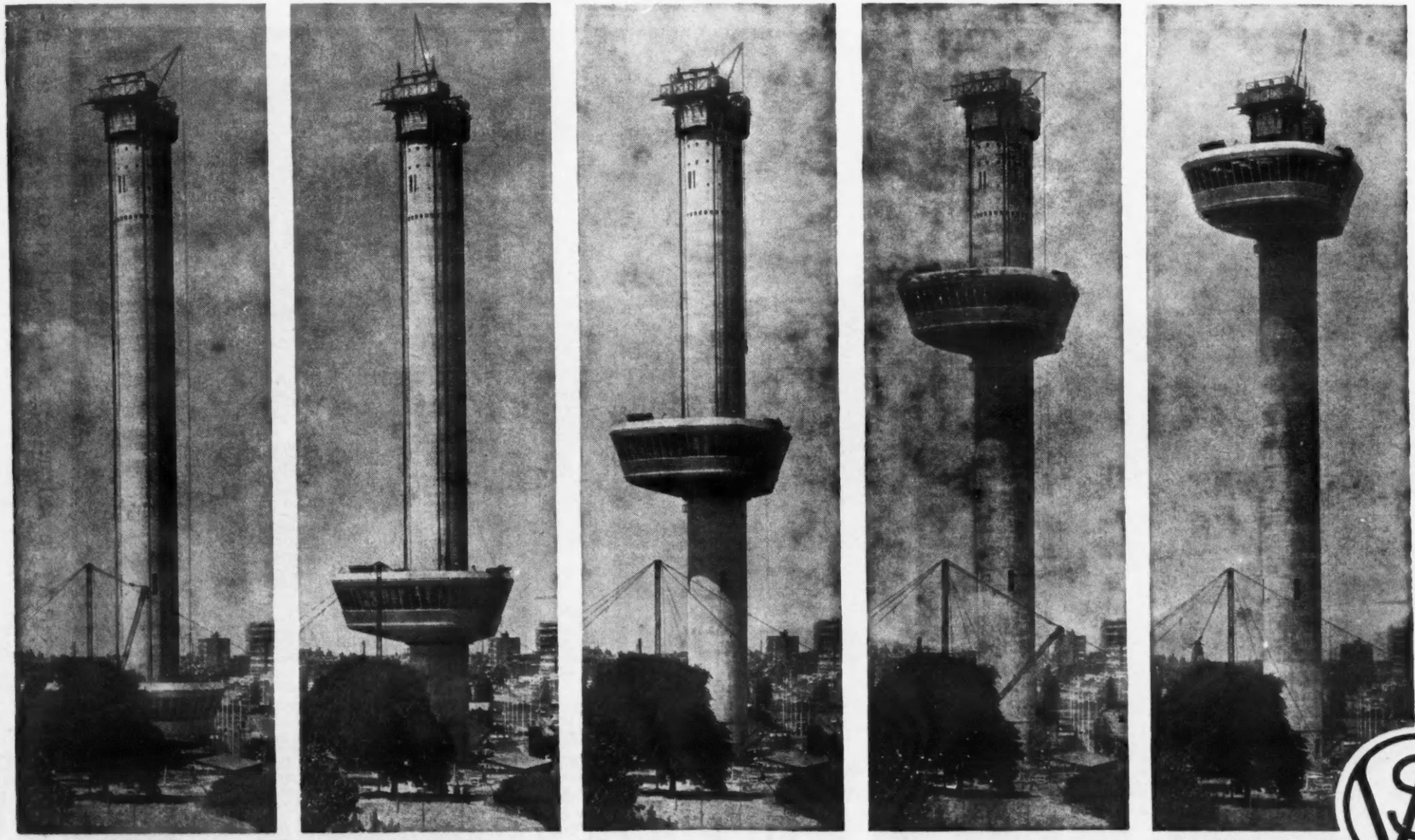

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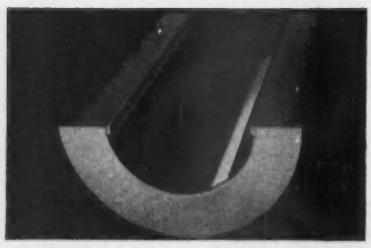
Already hundreds of ships have been fitted with bearings of TUFNOL, the strong, hardwearing material specially developed for this work. Keep up to date—send for further information on TUFNOL.



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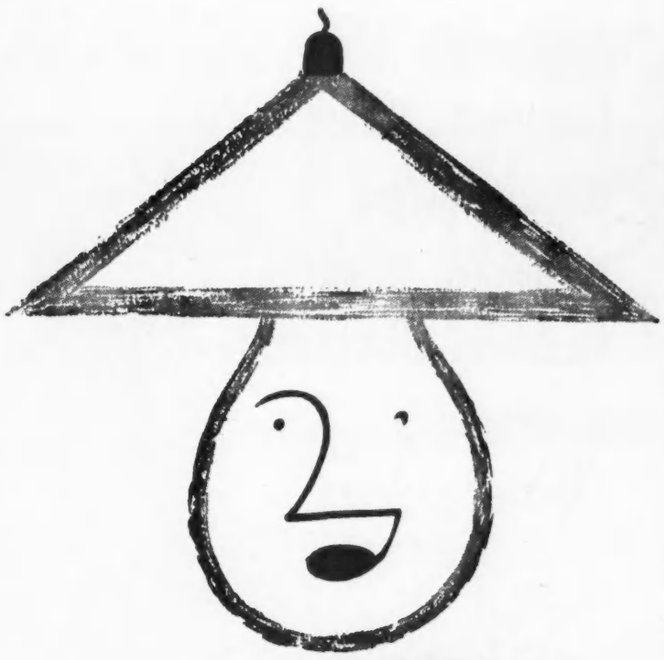

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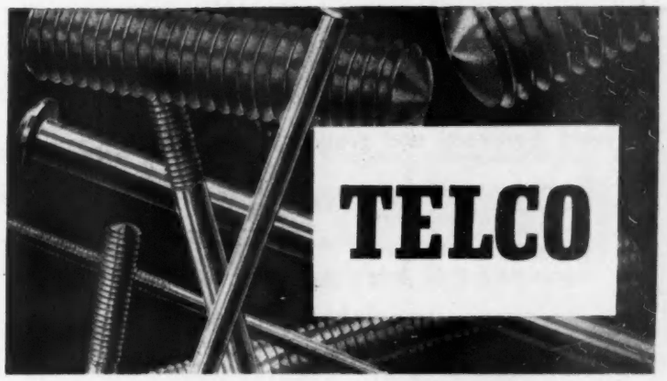

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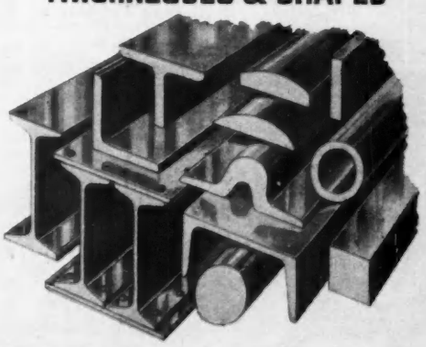

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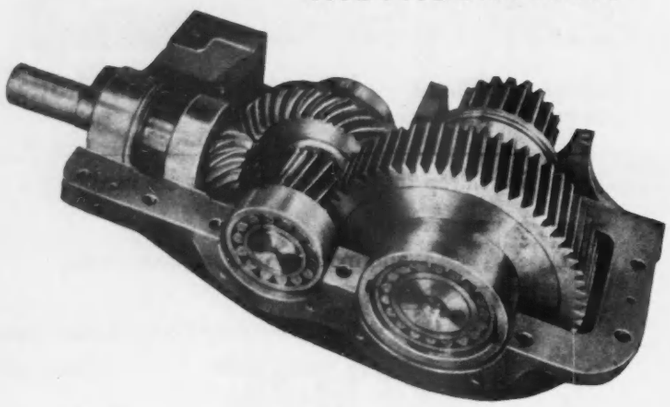

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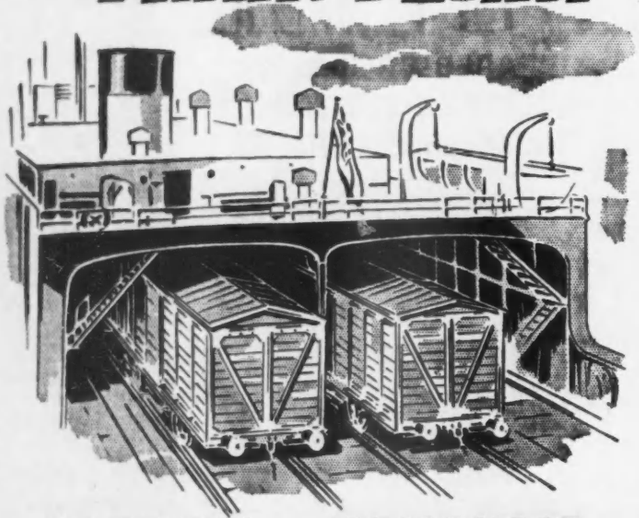

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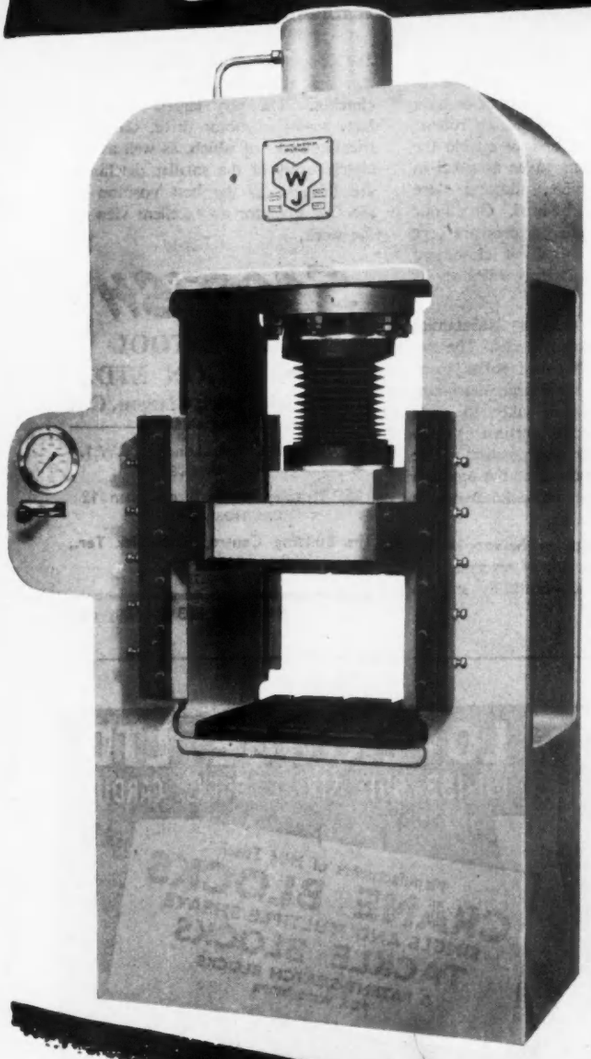

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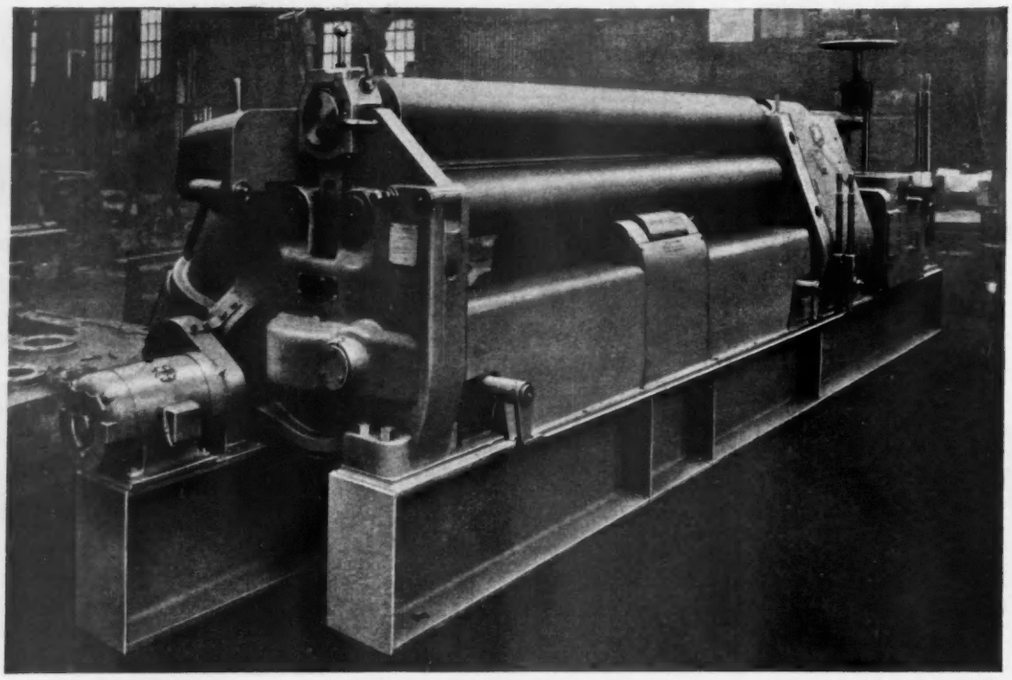

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Our combined machines are similar in general construction to our well-known pyramid type Plate Bending Rolls, with the addition of a fourth roller for plate levelling purposes. A wide range of sizes is available : from 1¼" to 1¾" plate thickness and 4' to 14' plate width.

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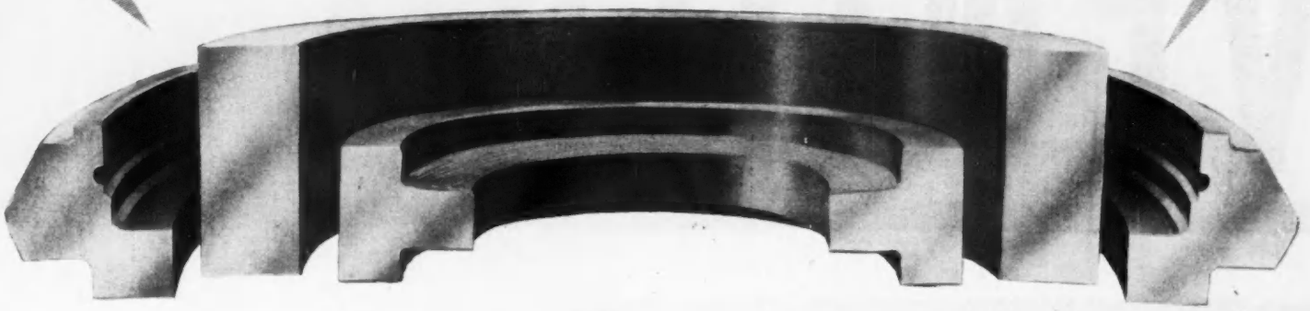

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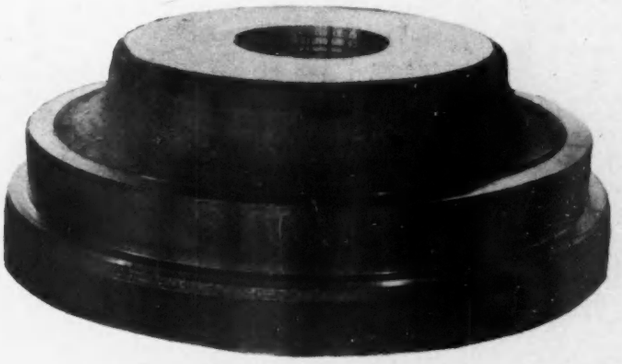

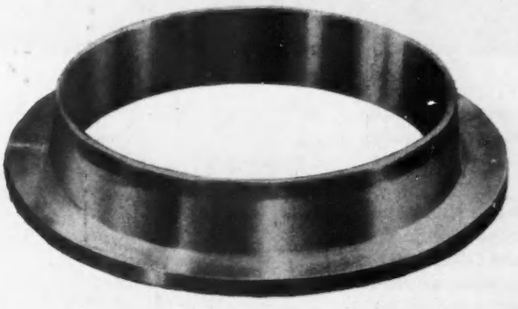

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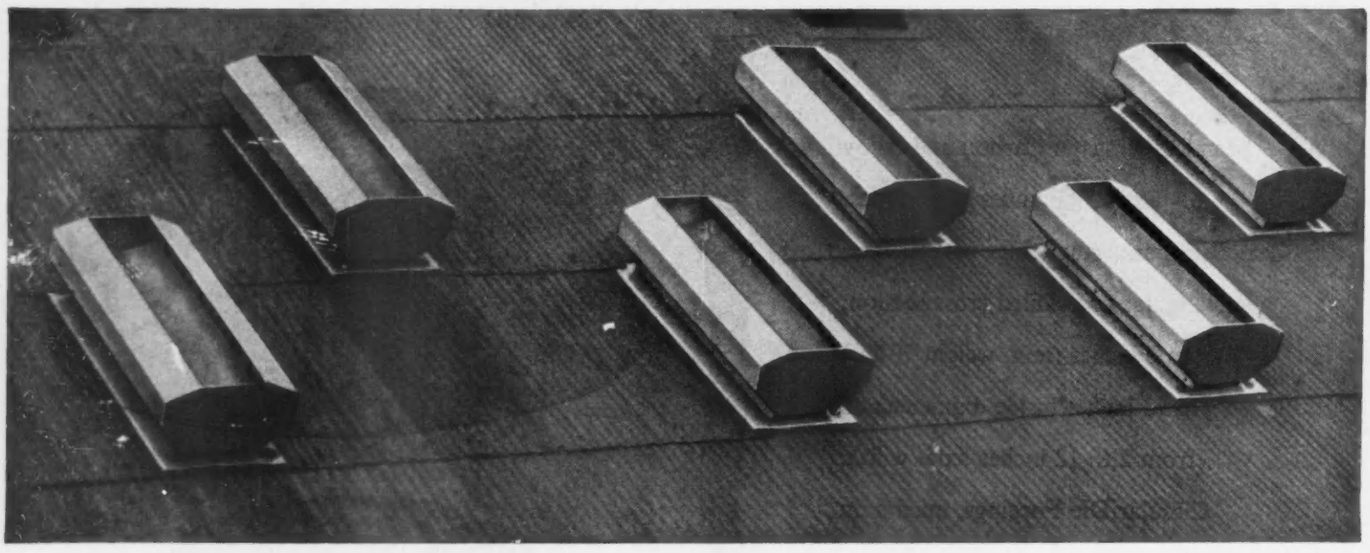

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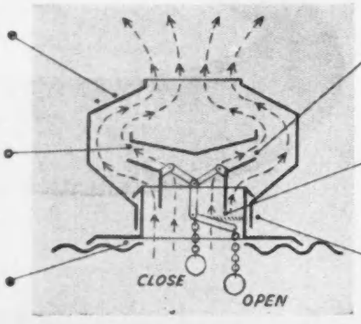
Base suitable for fixing into patent glazing or roof sheeting.



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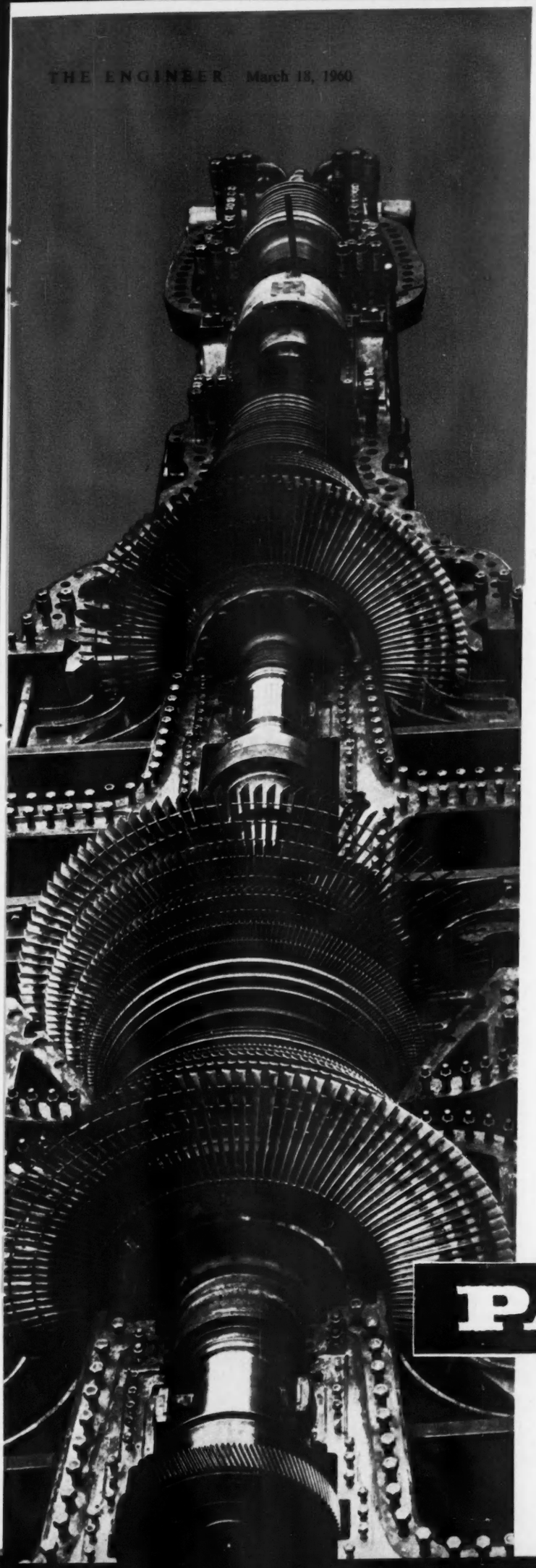

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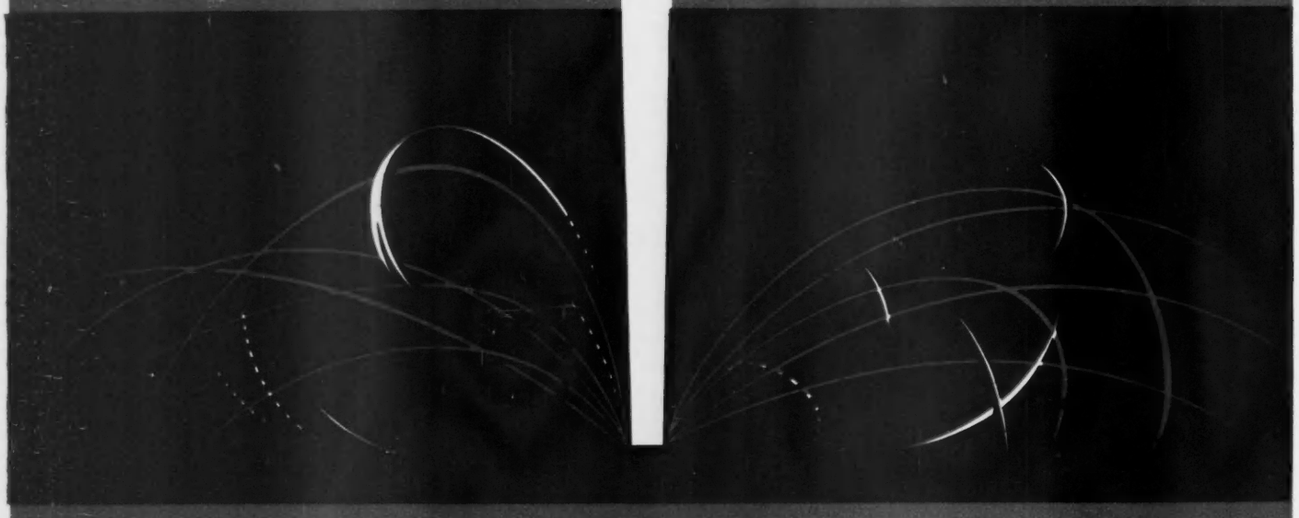

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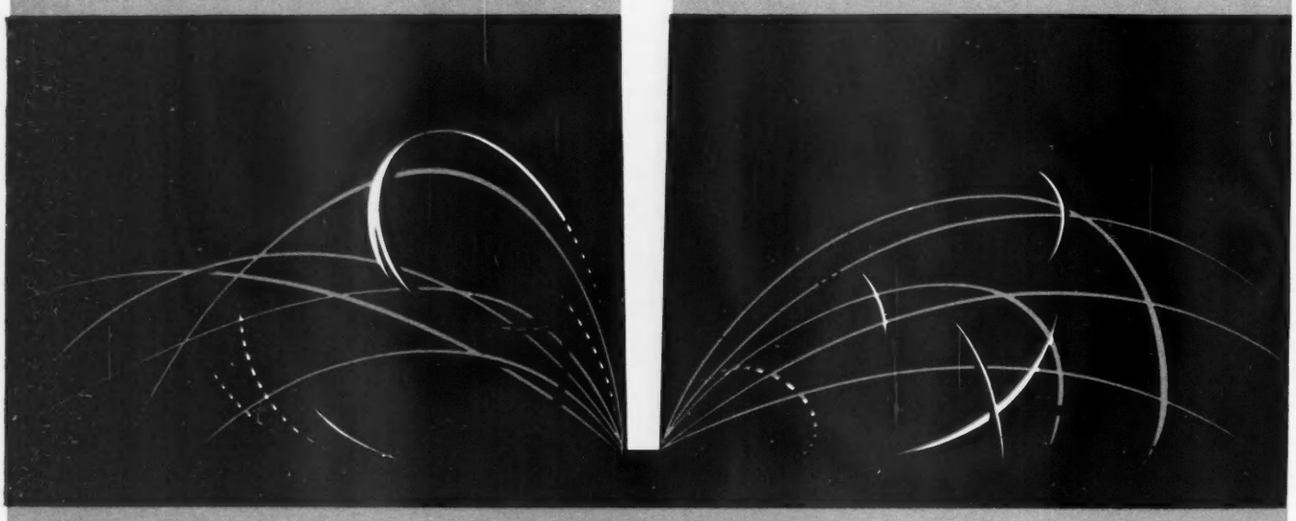

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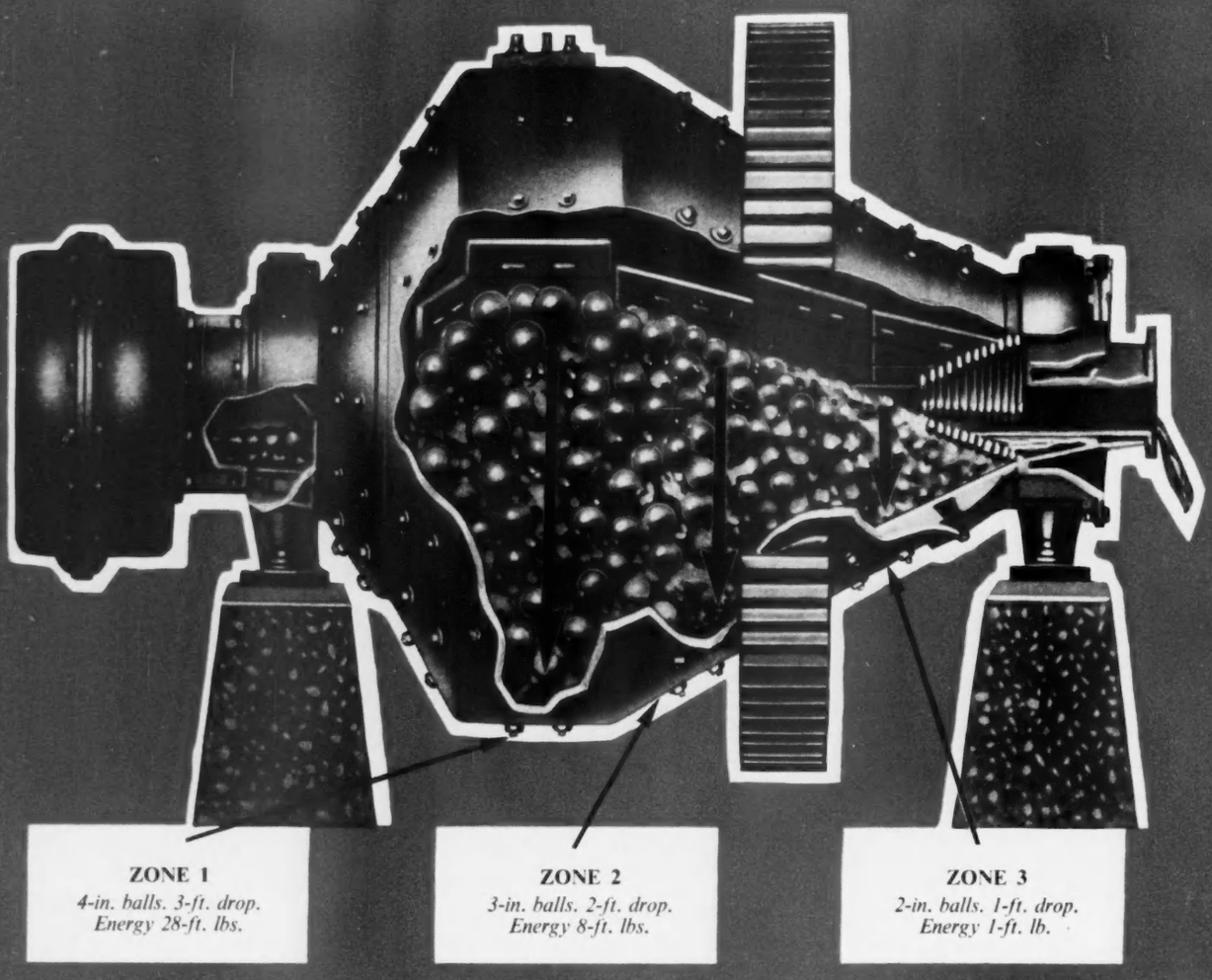

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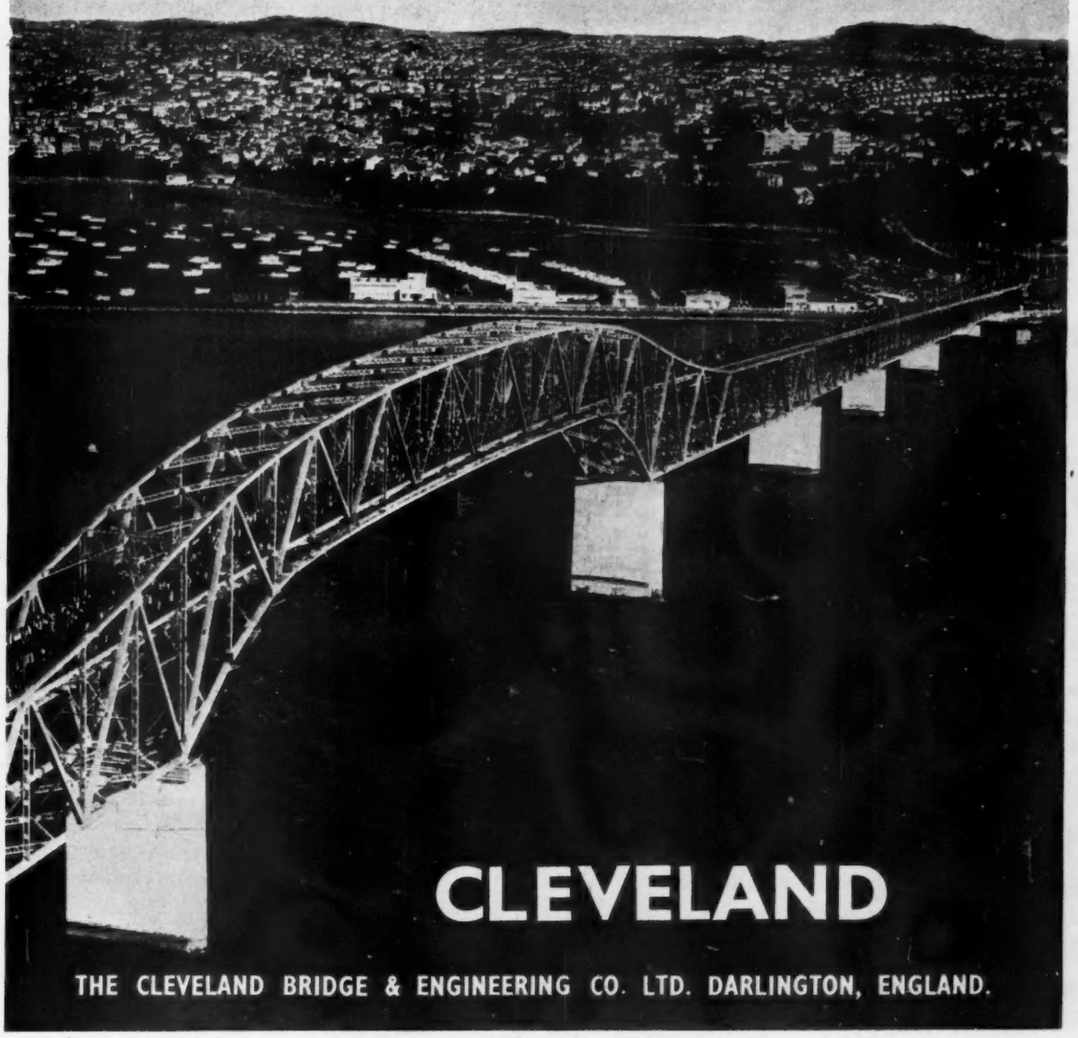

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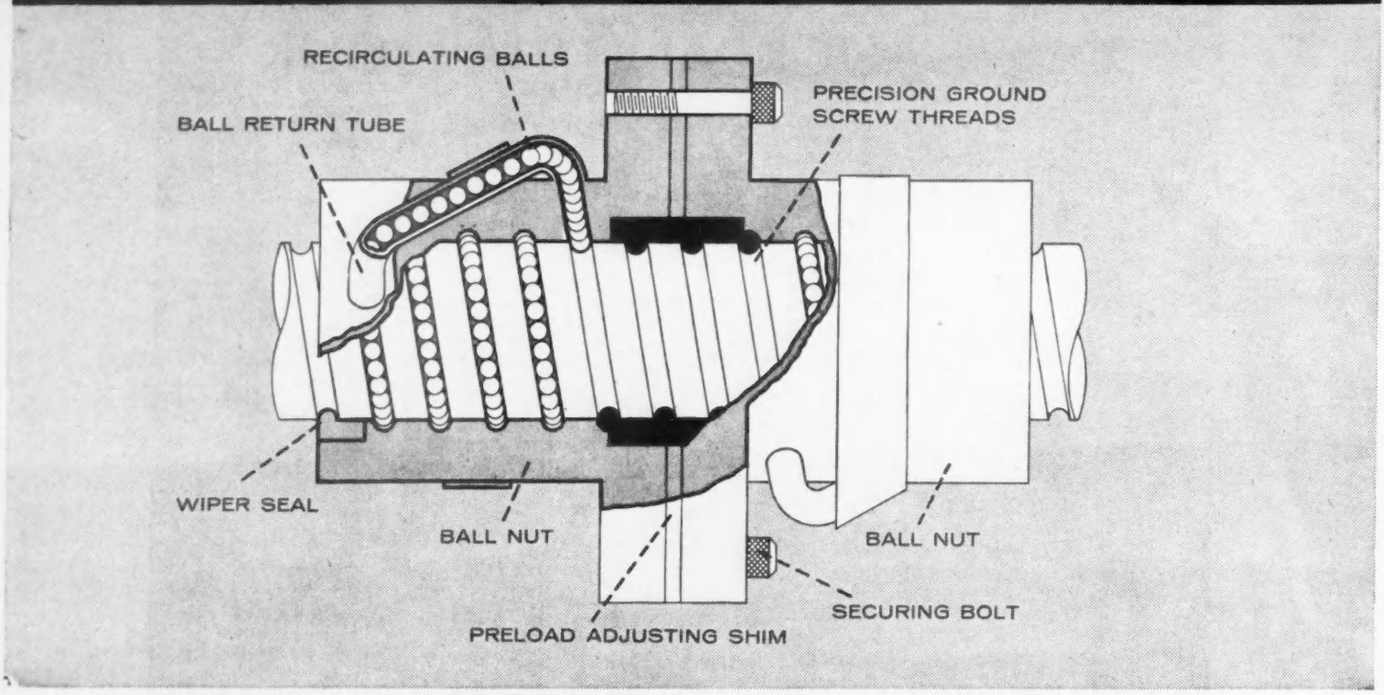

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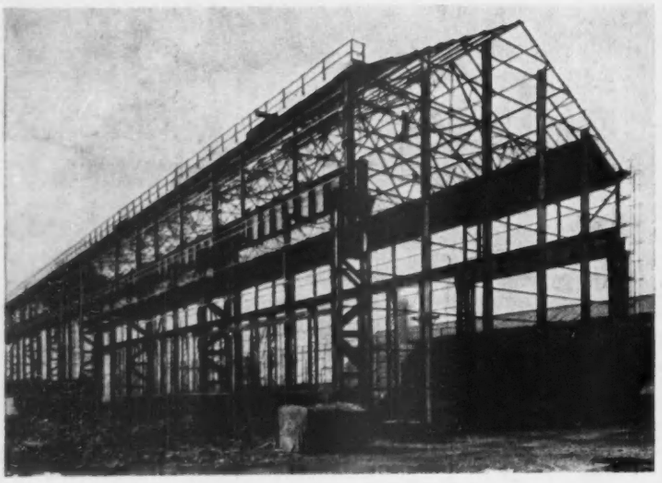

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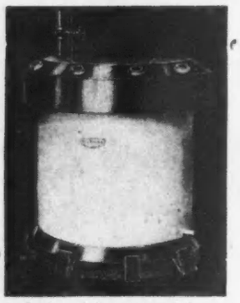

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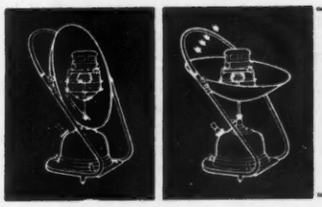

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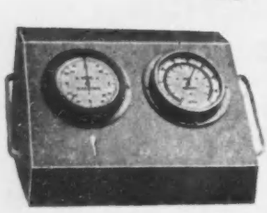

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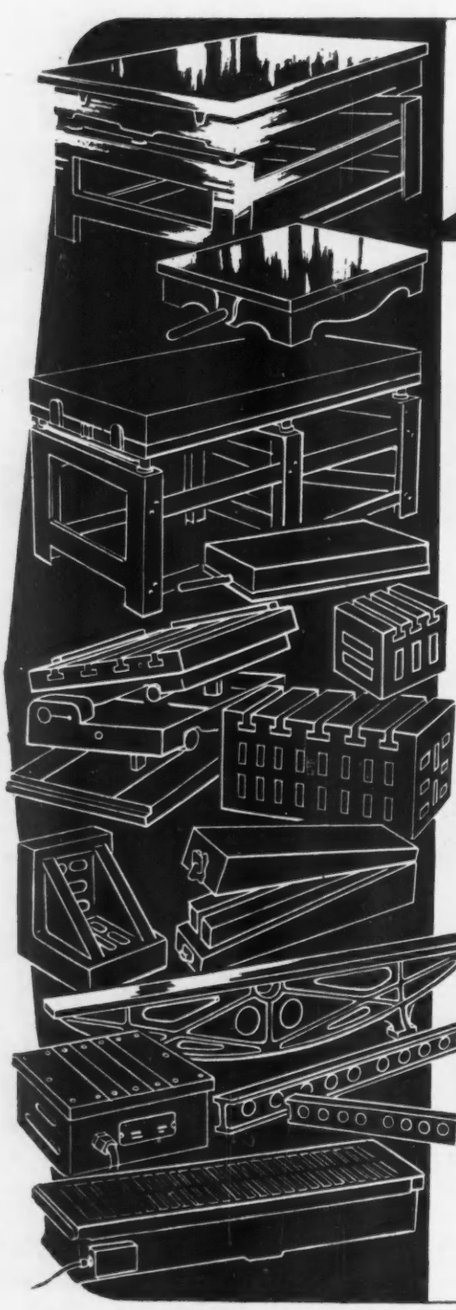

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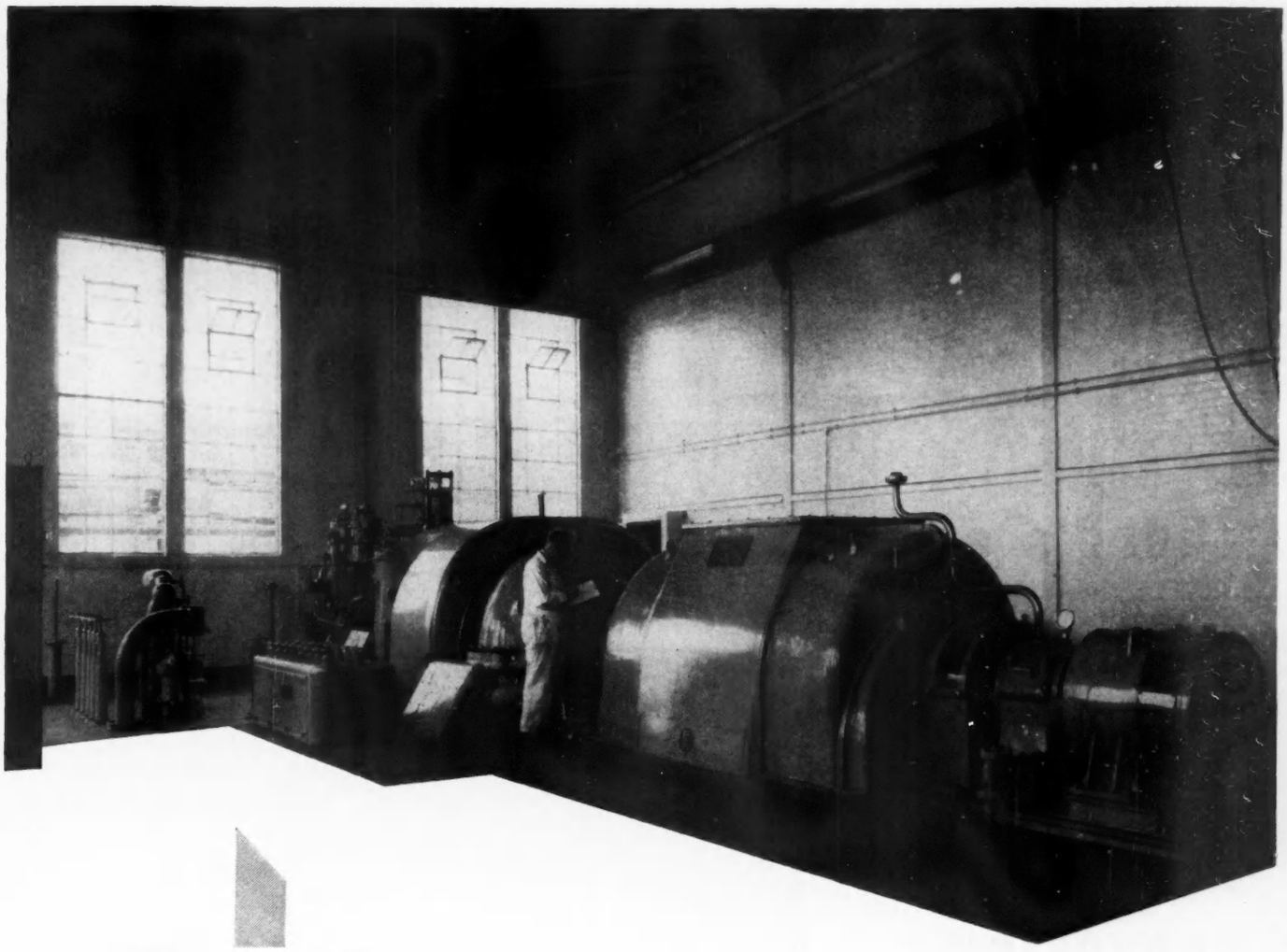

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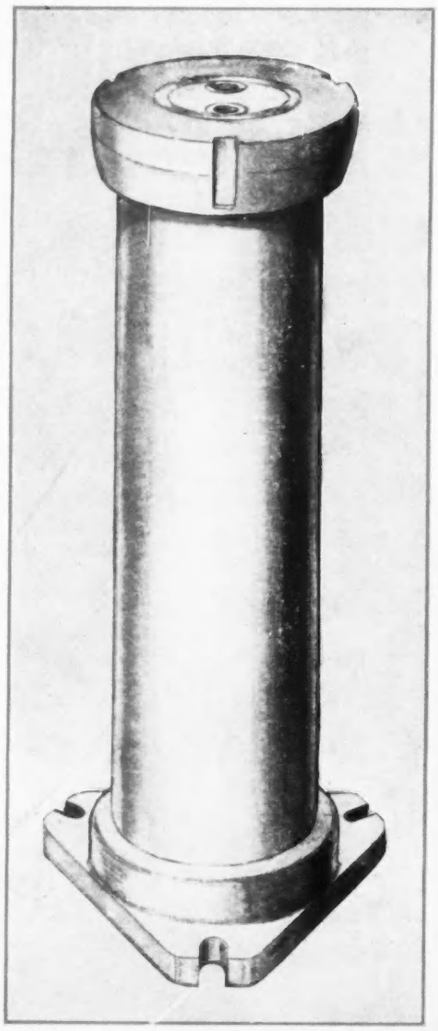

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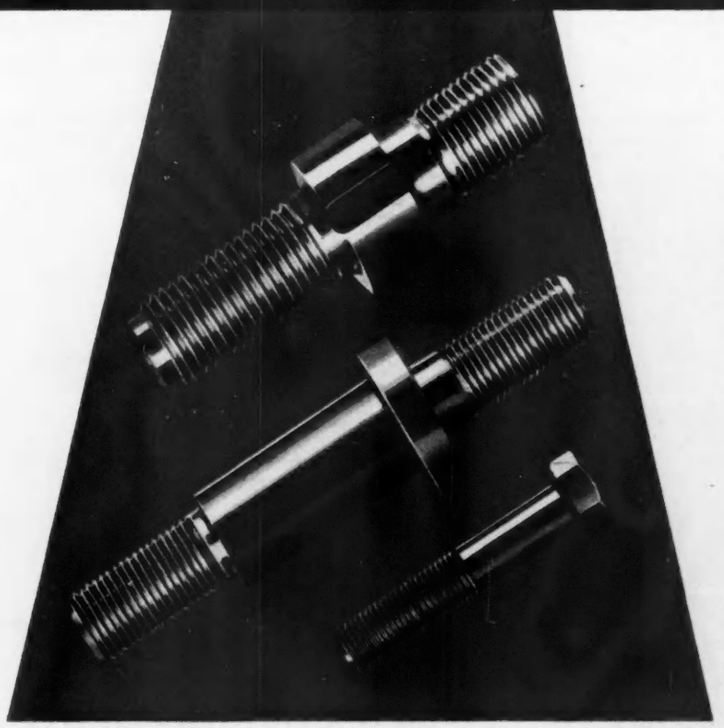

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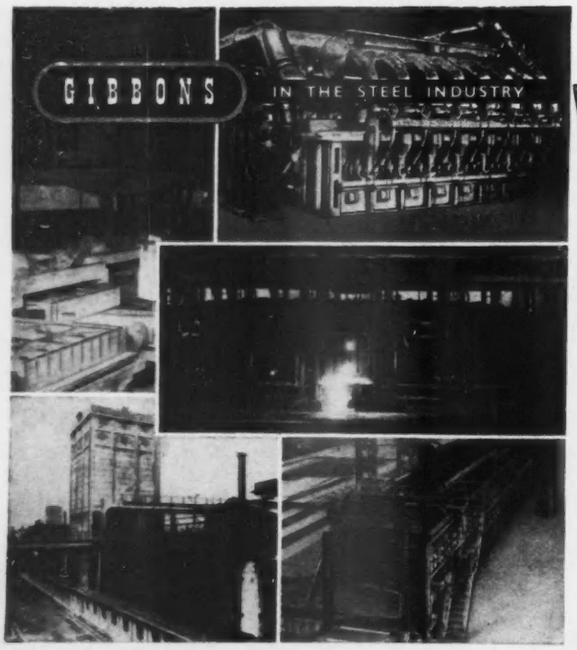

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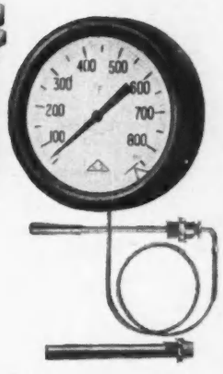

Distance-type Mercury-in-
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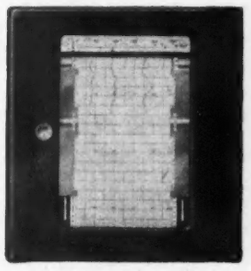

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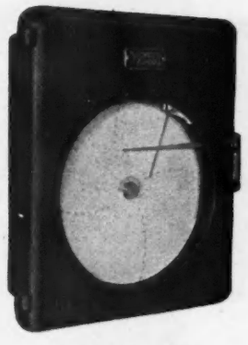

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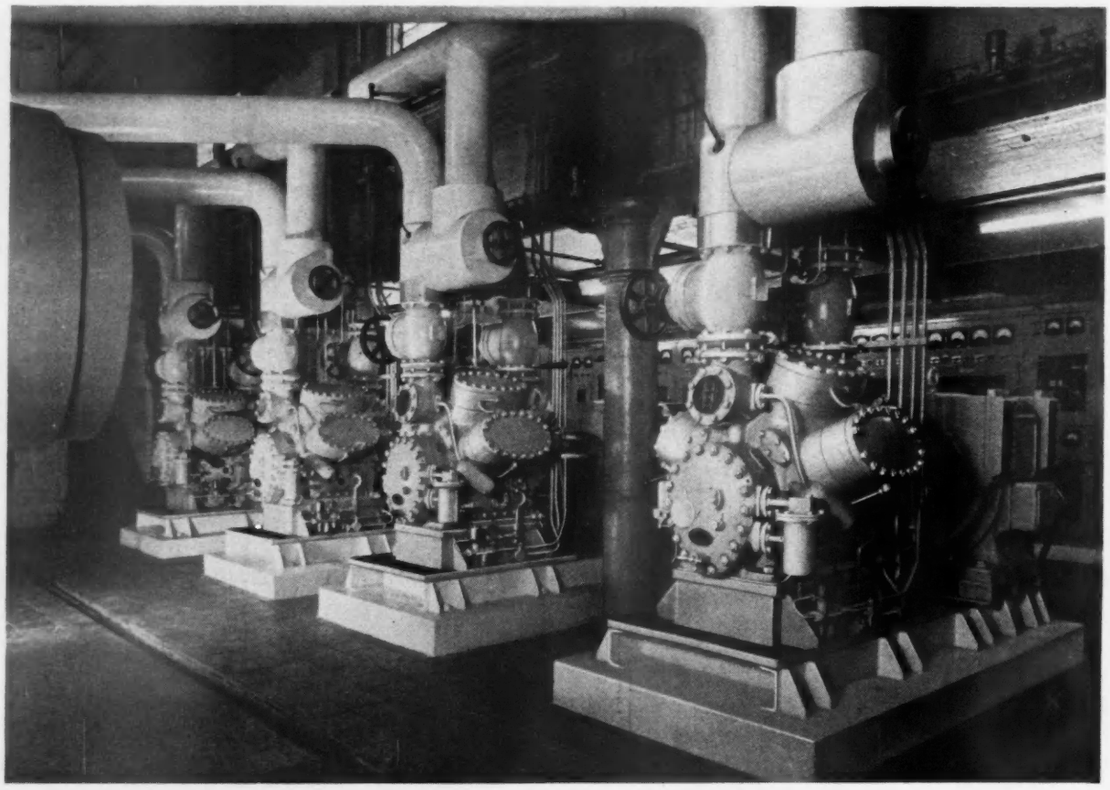

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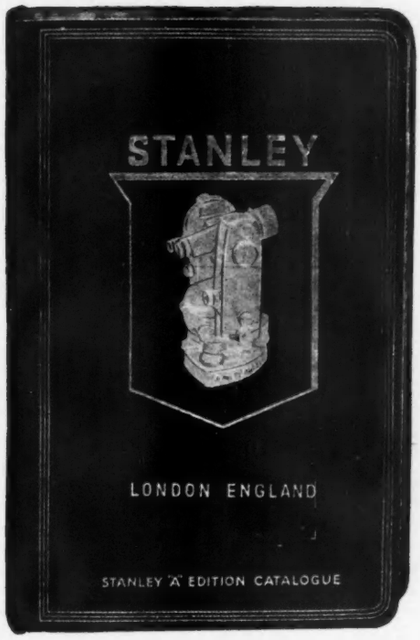

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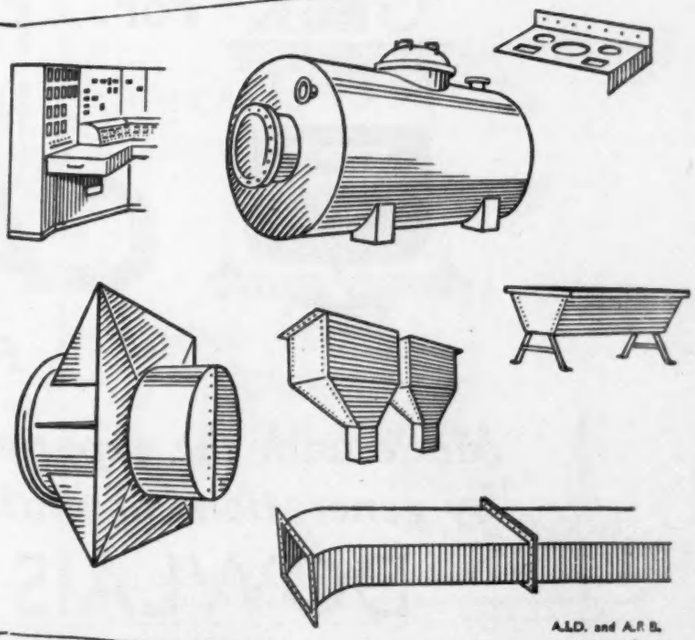

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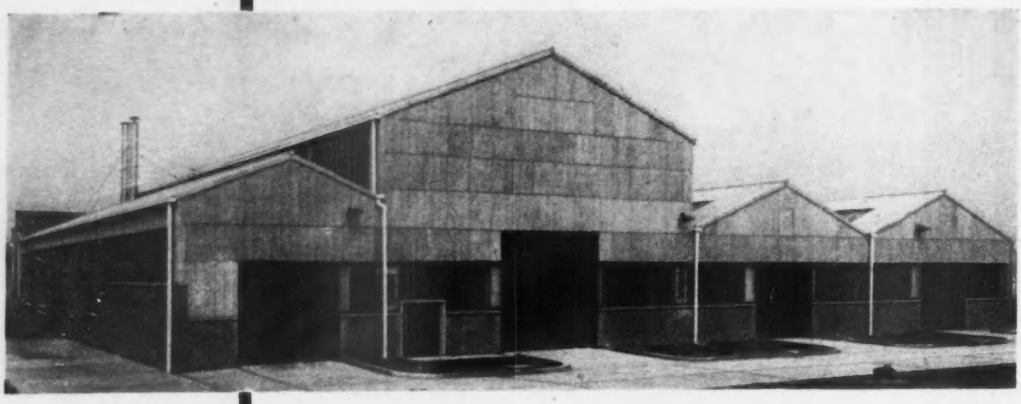

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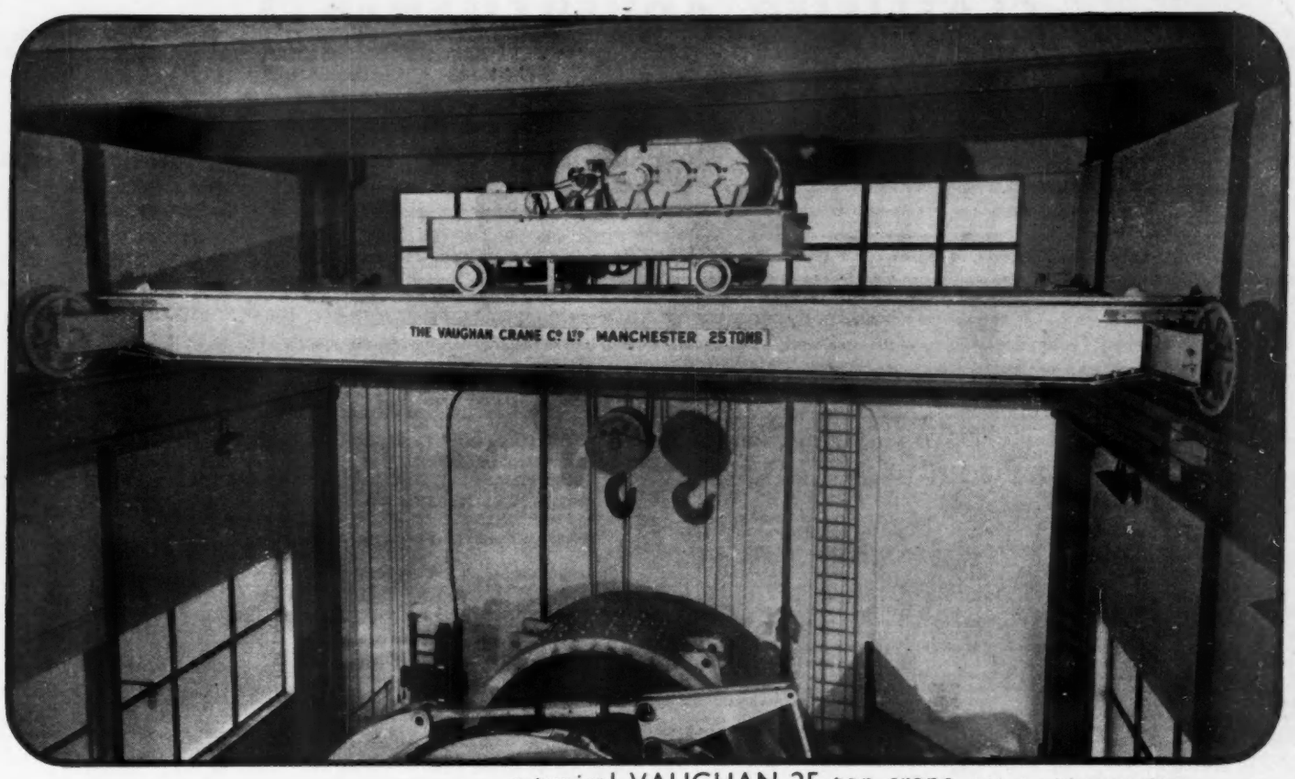

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Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to :—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

CITY OF OXFORD EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

LECTURERS

Applications are invited for the following new posts to commence in September, 1960 :

SENIOR LECTURER in MECHANICAL ENGINEERING to specialise in Thermodynamics in Diploma and H.N.C. courses and to take some responsibility for work in the Heat Engines Laboratory. A good honours degree and industrial and teaching experience essential.

LECTURER in MATHEMATICS for Mathematics up to H.N.C. standard in National Certificate and Diploma courses. Applicants should possess either a special degree in Mathematics or a good general degree including Pure and Applied Mathematics, and have had teaching experience.

ASSISTANT LECTURER, GRADE "B" in WORKSHOP ENGINEERING to teach Calculations, Science, Drawing and Workshop Technology in Machine Shop Engineering courses. A knowledge of Pattern Making and/or Foundry work would be an advantage. Applicants must hold H.N.C. Production or Full Tech. City and Guilds M.S.E. Certificates.

Salaries on Burnham Technical Scale, i.e.

Senior Lecturer (Men) : £1550 by £50 to £1750 per annum.

Lecturer (Men) : £1370 by £35 to £1550 per annum.

Grade "B" (Men) : £700 by £27 10s. to £1150 per annum.

Increments above the minimum of the scale may be allowed for approved industrial experience.

Further particulars and application forms (stamped addressed envelope) can be obtained from The Principal, College of Technology, Headington Road, Oxford, to whom applications should be returned by April 6th, 1960. E9210

WEST RIDING COUNTY COUNCIL

KEIGHLEY TECHNICAL COLLEGE AND SCHOOL OF ART

HEAD OF DEPARTMENT OF ENGINEERING

Applications are invited for the post of HEAD OF DEPARTMENT OF ENGINEERING, to commence on 1st September, 1960. Salary Grade III Head of Department. £1800 by £50 to £1950 per annum.

Candidates should be Graduates who have had Teaching and Industrial experience and who have enthusiasm for continuing the development of the work on Machine Tools which has been a feature of the Department.

Details from the Borough Education Officer, Town Hall Square, Keighley. E9237

UNIVERSITY OF LONDON

WYE COLLEGE

EXPERIMENTAL OFFICER

EXPERIMENTAL OFFICER required for Department of Hop Research, to work at the National Institute of Agricultural Engineering on engineering problems connected with the mechanisation of hops and hop drying. Candidates should possess Engineering Degree, H.N.C. or equivalent qualifications and have experience of research work. Minimum age 28 years, superannuation, five-day week. Salary scale £954–£1166. Application forms from Secretary, N.I.A.E., Wrest Park, Silsoe, Beds. E9230

MIDDLESEX COUNTY COUNCIL

HEATING ENGINEERING ASSISTANT

HEATING ENGINEERING ASSISTANT required at Westminster A.P.T. III, £910–£1095. Commencing salary according to qualifications and experience, for preparation of drawings and specifications for heating systems and hot and cold water services in schools and other buildings.

Application forms (stamped addressed foolscap envelope) from County Architect, 1, Queen Anne's Gate Buildings, Dartmouth Street, S.W.1, returnable by 3rd April. (Quote C.110E.) E9191

PUBLIC APPOINTMENTS

UNIVERSITY OF LONDON

DEPUTY ENGINEER

DEPUTY ENGINEER, University of London, Senate House.

Applications are invited from professionally qualified Engineers with practical experience in the control of staffs and the maintenance of large-scale heating and electrical installations for the post of DEPUTY ENGINEER, located at Senate House, Bloomsbury. He will be responsible to the Resident Engineer for the provision and supervision of all engineering services for the developing Bloomsbury site, including direct electric, oil-fired and thermal storage heating installations, ventilation and air conditioning plant.

Present salary scale : £900 by £50 to £1200. Starting point according to age and experience, with generous leave, superannuation and family allowances.

Applications, stating full details of training and experience, by 30th April, 1960, to the Maintenance Officer, University of London, Senate House, W.C.1, from whom further particulars may be obtained. E9192

CITY OF BRADFORD SEWAGE DEPARTMENT

ASSISTANT ENGINEER

Applications are invited for the above superannuable appointment in Special Grade (£785–£1070) in the office of the Sewage Works Engineer and Manager, Esholt Hall, near Shipley, Yorkshire. Commencing salary according to qualifications and experience.

Candidates should have received a good training in civil engineering. Minimum qualifications required are Graduate Membership of the Institution of Civil Engineers, or Final Examination of the Institution of Municipal Engineers. Experience in the design of sewerage and sewage disposal works would be an advantage.

Applications, stating age, experience and qualifications together with the names of two referees, and enclosed in an envelope endorsed "Assistant Engineer, Sewage Department," should reach me by 4th April, 1960.

HENRY PATTEN,
Town Clerk.

Town Hall,
Bradford, 1. E9201

WAR OFFICE

LANCASHIRE

ENGINEER/CHEMIST/PHYSICIST

War Office require an ENGINEER/CHEMIST/PHYSICIST in Lancashire to assist in setting to work, control and calculation of characteristics of novel physico-chemical process ; also to advise on and develop new types of monitoring instruments. Qualifications : Hons. degree in Chem. Engineering, Physics or Chemistry or A.M.I.Chem.E.; A.M.I. Mech.E.; A.R.I.C. or equivalent. Good knowledge of mathematics. Experience of chemical plant control an advantage but not essential. Familiarity with Chemical Works Regulations and some experience on safety matters. Salary : £1245 to £1680. Opportunities for establishment. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting reference F 631/9A. E9245

MARSTON GREEN MATERNITY HOSPITAL,

BERWICKS LANE, MARSTON GREEN, NEAR BIRMINGHAM

ASSISTANT ENGINEER

ASSISTANT ENGINEER required. Applicants must have completed an apprenticeship in mechanical engineering and have sound knowledge of the principles and practice of hospital boiler plant, engineering and electrical services generally. Preference will be given to candidate who has studied for the Ordinary National or its equivalent. Salary £545 rising to £670 p.a. Post permanent and superannuable. Applications, giving full details and naming 3 referees to Hospital Secretary within 21 days. E9223

PUBLIC APPOINTMENTS

CENTRAL ELECTRICITY GENERATING BOARD

GENERAL ASSISTANT ENGINEER

GENERAL ASSISTANT ENGINEER is required in the Power Plant Design Branch of the Design and Construction Department at Headquarters, London, S.E.1. The Branch is responsible for the design of boiler, turbo-generator and ancillary plant in conventional power stations and for the design of plant other than reactors and their ancillaries in nuclear power stations. It works in close collaboration with those responsible for the operation of the Board's power stations and with the Board's Research and Development Department.

To enable the successful candidate to become familiar with the activities of the Branch he will be employed initially on work connected with technical and economic problems of a general nature and will subsequently be required, either to continue with this work or to specialise in a particular field according to his aptitude and the availability of suitable openings.

Candidates should have a degree in mechanical engineering and some industrial experience. Previous experience of power station plant would be advantageous but is not essential.

Salary within the range £1140 to £1350 p.a.

Applications, stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24-30, Holborn, London, E.C.1, by 28th March. Envelopes should be marked "Confidential" Ref. ENG/75. E9229

SUDAN GEZIRA BOARD

AGRICULTURAL ENGINEER

Applications are invited from those suitably qualified to fill a vacancy in the Sudan Gezira Board as an AGRICULTURAL ENGINEER. Candidates must be in possession of a degree in Agricultural Engineering and have at least ten years' experience in Agricultural Engineering. Experience on I.C. engines with alcohol fuel will be an advantage.

Duties will include mechanising agricultural operations under Gezira conditions, the improvement of the standard of efficiency and reduction of labour costs. Other main operations will include :

(a) Harvesting and baling.
(b) Ditch maintenance.
(c) Rotary Hoe work.
(d) Road grading and maintenance (earth roads).
(e) Draw bar and other tests of Crawler and Wheeled tractors.

Age not under 30 (thirty) years.

Appointment will be on a contract initially for a period of five years.

Commencing salary £S1800 with annual increments. A variable cost of living allowance is payable and an initial outfit allowance of £S60 is payable on appointment.

Housing is provided free by the Board. Hard furnishings will be supplied at a nominal rent.

Free air passage is provided. Eighty days' leave annually with free passage.

There is no income tax payable in the Sudan at present.

Applicants should apply in writing, quoting qualifications, experience and age, together with copies of two recent testimonials to Sudan Embassy, Appointments Section, 3, Cleveland Row, St. James's, London, S.W.1.

Closing date, 30th April, 1960. E9235

MINISTRY OF AVIATION

LONDON

CHEMISTS, PHYSICISTS OR ENGINEERS

Ministry of Aviation requires in London TWO CHEMISTS, PHYSICISTS OR ENGINEERS to assist senior officers on safety matters connected with ionising radiation hazards and to inspect establishments. Considerable travelling involved. Qualifications : Hons. degree in chemistry, chemical engineering, physics, A.R.I.C., A.M.I.Chem.E., A.I.P., or equivalent or have served reocognised engineering apprenticeship and A.M.I.Mech.E., A.M.I.E.E. or A.M.I.C.E. Knowledge of radioactive materials, apparatus and appropriate safety devices required. Selected candidates will undergo period of training. Salary : £805 (age 25) to £1260. Opportunities for establishment. Forms from Ministry of Labour, Technical and Scientific Register K), 26, King Street, London, S.W.1, quoting reference F.154/0A. Closing date, 8 April, 1960 E9236

PUBLIC APPOINTMENTS

WORCESTERSHIRE COUNTY COUNCIL

COUNTY SURVEYOR'S DEPARTMENT

RESIDENT ENGINEERS, &c.

Applications are invited for the following appointments, primarily in connection with supervision of contract work on a 28-miles length of the Bristol-Birmingham Motorway, including 63 bridges :

(a) CHIEF PROJECT ENGINEER. Scale "F" (£1790–£2085).
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(c) SENIOR ASSISTANT PROJECT ENGINEER (Land, Accommodation Works, Measurements, Claims). Scale "B" (£1310–£1485).
(d)(i) SECTION ENGINEERS. Scale "B" (£1310–£1485).
(ii) SECTION ENGINEERS. Scale "A" (£1215–£1390).
(e) RESIDENT ENGINEERS (Measurements and Claims). Scale "A" (£1215–£1390).
(f)(i) ASSISTANT SECTION ENGINEERS. A.P.T. V (£1220–£1375).
(ii) ASSISTANT SECTION ENGINEERS. A.P.T. IV (£1065–£1220).
(iii) ASSISTANT SECTION ENGINEERS. A.P.T. III (£880–£1065).
(g)(i) ASSISTANT RESIDENT ENGINEER (Site Soils Laboratory). A.P.T. IV (£1065–£1220).
(ii) ASSISTANT RESIDENT ENGINEER (Site Soils Laboratory). A.P.T. III (£880–£1065).
(h) GRADUATE ASSISTANTS. A.P.T. I (£610–£765).
(j) LABORATORY TECHNICIANS. Misc. VI (£715–£775).
(k) DRAUGHTSMEN. Misc. VI (£715–£775).
(l) CLERKS OF WORKS. £1000 per annum.
(m) INSPECTORS. £750 per annum.

The appointments are superannuable, and for a period of approximately two years. Conditions of service are those of the appropriate National Joint Council. "Essential user" scales of car allowances and subsistence allowances at "outside officer" rates will be payable for most of the engineering appointments. Certain site allowances will also be payable for week-end inspections. The County Council will consider the payment of a proportion of furniture removal expenses, and may be able to offer temporary housing accommodation in a few instances.

Candidates for the engineering posts must have had suitable road or bridge design and construction experience, and qualifications proper to the appointment sought.

Graduate Assistants must possess an appropriate Degree, but applications from men now in their final University year would be considered.

Laboratory Technicians should have had appropriate practical experience in the sampling and testing of soils and road materials.

Draughtsmen should be experienced in road and bridge work detailing and should preferably be conversant with the use of surveying instruments.

Clerks of Works and Inspectors must have had previous experience in these respective positions on large-scale road or bridge contracts.

Previous Local Government experience is not essential for any of the posts.

Applications should be submitted as soon as possible to the County Surveyor, County Buildings, Worcester, in the following form : Appointment and Grade sought ; Name ; Age ; Theoretical Qualifications ; Present Appointment, Grade and Salary ; Previous Appointments and Experience ; Whether car-owning ; When Available ; Particulars of two Referees. (X.23.) E9150

MIDDLESEX COUNTY COUNCIL

ENGINEERING INSPECTOR

Outside ENGINEERING INSPECTOR required to supervise heating and hot water contracts. A.P.T. II £765 to £880 plus London Weighting up to £30 p.a. Commencing salary according to qualifications and experience. Established and pensionable. Practical experience with Contractors essential. A motor car allowance will be paid. Prescribed conditions. Application form from County Architect, 1, Queen Anne's Gate Buildings, Dartmouth Street, S.W.1 (s.a. f'scap env.) returnable by 28th March. (Quote C.131 E.) E9225

BOOKS and PUBLICATIONS

HMSO

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Prepared to facilitate the dimensional specification of fine and coarse pitch gears of 20 deg. pressure angle, required to meet minimum backlash conditions, this memorandum specifies full tolerances for four classes of gears for measurement by the double flank rolling test. The involute racks are defined. Comprehensive tables, charts, formulae, worked examples, specimen production drawings. **17s. 6d.** (*post* 10*d*.)

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PUBLIC APPOINTMENTS

RHODESIA RAILWAYS

VACANCIES FOR SIGNALS AND COMMUNICATIONS ENGINEERS

Vacancies exist on the Permanent Staff for Signals and Communications Engineers for service in the Chief Engineer's Department of the Rhodesia Railways.

Preference will be given to applicants who have had previous experience in the design, installation and maintenance of modern colour light signalling and/or telecommunication systems with a Railway Administration or with a firm of equipment manufacturers.

Applicants should hold a degree in Electrical Engineering at a recognised University or be Corporate Members of the Institution of Electrical Engineers. Applicants who have passed Parts I and II of the Institution examinations will be considered for appointment to the grade of Technical Assistant until such time as they become Corporate Members and are, therefore, eligible for transfer to the Professional Grade. Successful candidates will be expected to become Corporate Members of the Institution of Railway Signal Engineers in due course.

The salary scale for Assistant Engineers is £1000 to £1800 per annum, plus a Cost of Living Allowance at present calculated on 12 per cent of the basic salary, subject to a maximum of £13 15s. per month. The commencing salary will depend upon previous experience of applicants. The annual increments in the above scale are as follows :

£1000 by £100 to £1200.
£1200 by £50 to £1500.
£1500 by £100 to £1800.

Further advancement to the grade of District Signals and Communications Engineer on the salary scale £1800 by £100 to £2100 is possible as and when vacancies occur. Promotion to these posts is by selection.

Membership of the Contributory Pension Fund and Medical Fund is obligatory, and the usual Railway privileges in respect of travelling concessions, leave, &c., will apply.

Income Tax in the Federation is not unreasonable, and at the present time, a married man with one child, earning £1100 per annum would not be liable.

Housing is provided at a moderate rental for married Engineers ; the rental payable is £7 10s. per month for Officers in receipt of a salary under £1700 per annum, and £10 per month for Officers in receipt of higher salaries.

Full particulars with regard to age, training, qualifications and experience should be submitted together with copies of recent testimonials to :

The London Agent,
Rhodesia Railways,
241, Salisbury House,
London Wall,
London, E.C.2,

from whom full details regarding conditions of service may be obtained. E9204

ILFORD AND BARKING GROUP HOSPITAL MANAGEMENT COMMITTEE

GROUP WORKS DEPARTMENT

ILFORD MATERNITY HOSPITAL, EASTERN AVENUE, ILFORD, ESSEX. (Adjacent to Newbury Park Station—Central London Line)

ASSISTANT ENGINEER

ASSISTANT ENGINEER required to assist Superintendent Engineer in the supervision of the Engineering and Building Services in this Group.

Applicants must have a first class knowledge of Mechanical Engineering and Building Services, also drawing board experience. Knowledge of Electrical Installations would be an advantage. Preference will be given to candidates who are studying Engineering Technology.

The post is subject to the Terms and Conditions of the appropriate Whitley Council. Salary £575 (5 by £25) to £700 plus London Weighting. (Salary under review.)

Apply in writing, stating age, qualifications, details of experience, together with names and addresses of three referees to the Group Secretary, King George Hospital, Ilford, Essex, as soon as possible. E9233

GOVERNMENT OF MAURITIUS

FACTORY INSPECTOR AND TRADE TESTING OFFICER

FACTORY INSPECTOR AND TRADE TESTING OFFICER (male, aged 30 to 45) required, to be responsible to Labour Commissioner and to perform duties assigned by Commissioner. Duties to include administration of Factories and Apprentices Ordinances and responsibility of a trade testing scheme. Candidates must possess Corporate Membership of Institution of Mechanical Engineers or Graduateship of Institution or Engineering Degree or Diploma recognised as granting exemption from Associate Membership examination of the Institution, and at least two years' training in industrial mechanical engineering workshops or Corporate Membership or Graduateship of Institution of Engineering, Australia. In the case of candidate possessing latter qualification, he must have had at least two years' practical experience. A working knowledge of French would be an advantage. Post on contract (resettlement grant terms).

Salary scale : £1089–£1665 per annum. Quarters available at low rental. Tour of service 3 years. Low income tax.

Further particulars and application forms from Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.132/52/04/D4. Candidates should state their full names when applying. E9185

PUBLIC APPOINTMENTS

CITY OF HOBART, TASMANIA—AUSTRALIA

ENGINEERS

Due to an accelerated programme of Works to match an expanding City, the Hobart City Council requires additional Engineering staff, and the following vacancies exist :

CITY ENGINEER'S DEPARTMENT

1. ASSISTANT DESIGN ENGINEER. Present salary £A1752–£A1798–£A1846.*

Duties : To direct and control the activities of the Design Office under the Design Engineer.

Qualifications : (a) Corporate Membership of the Institution or equivalent. (b) Experience in design and construction and in handling staff. Managerial ability is stressed.

2. ASSISTANT PLANNING ENGINEER. Present salary £A1752–£A1798–£A1846.*

Duties : (a) Pre-planning and programming projects and co-ordinating field works. (b) Budget and cost control.

Qualifications : (a) Corporate Membership of the Institution or equivalent. (b) Construction experience in civil or municipal works. (c) Costing and estimating experience is desirable.

3. HYDRAULIC ENGINEER (INVESTIGATION). Present salary £A1752–£A1798–£A1846.*

Duties : Responsible for investigations and design of works relating to the supply of water to the City.

Qualifications : (a) Corporate Membership of the Institution of equivalent. (b) Experience in Civil Engineering designs, especially hydraulic structures and works.

* (Marginal increase under consideration.)

Conditions of appointments :

(a) Three weeks' annual leave, long service leave after 10 years' service, liberal sick leave and superannuation benefits are available.

(b) Assistance will be given in finding adequate accommodation and in moving expenses (if applicable).

(c) Applications, giving full particulars of age, experience and present position, together with testimonials, to be sent to the undersigned, close at noon on 11th April, 1960.

H. J. R. COLE,
Town Clerk.
E9209

NATIONAL RESEARCH COUNCIL, CANADA

DIVISION OF BUILDING RESEARCH

SCIENTIFIC RESEARCH OPPORTUNITY

The Division of Building Research, National Research Council, has an opening for a CHEMIST or CHEMICAL ENGINEER, to assume responsibility for cement and concrete research in the Division. The research studies will embrace studies on the properties and use of concrete materials in well-equipped laboratories located in Ottawa.

Applicants should hold a Master's Degree from a recognised university and have from 3 to 5 years' experience in the cement or concrete field.

Salary will depend on education and experience. Applications and requests for further information should be addressed to :

Employment Officer,
National Research Council,
Ottawa, 2, Ontario,
Canada. E9176

TENDERS

FYLDE WATER BOARD

TENDERS FOR PROPOSED FISHMOOR FILTERS, BLACKBURN

The Board is proposing to ERECT a RAPID GRAVITY FILTRATION PLANT of 10 m.g.d. rated capacity adjacent to the Fishmoor Reservoir, Blackburn.

Firms desiring to be placed on the list of Tenderers should apply to the undersigned before Friday, 8th April, 1960, giving particulars of similar work carried out during recent years.

Preliminary details are available, but full Tender documents will be issued only to the selected Tenderers.

The date for submission of Tenders is 8th July 1960.

FRANK LAW, B.Sc. Tech., M.I.C.E.
Sefton Street, Engineer to the Board.
Blackpool. E9203

INDIA STORE DEPARTMENT

The Office of the Director General, India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, invites TENDERS for the following :—

(a) GEAR GRINDING MACHINES for Helical and Spur Gears. Maximum diameter of workpiece 300mm. Minimum diameter 10mm. Maximum number of teeth equals 130. Maximum helix angle, R.H. and L.H. equals 45 deg.

(b) GEAR SHAVING MACHINE. Maximum/minimum pitch diameters equals 300/25mm. Maximum module 6mm. Maximum face width 100mm.

Specifications, &c., can be obtained from the Coordination Branch, India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, at a cost of 10 shillings per Tender enquiry and is not refundable. Tenders are to be returned to the above address by Thursday, 28th April, 1960. Specimen copy of the above enquiries can be seen at Engineering Branch, I.S.D., under the following references :

(a) 2039/59/SSB/Eng.3.
(b) 2041/59/SSB/Eng.3. E9226

Classified Advts. continued on page 118

TENDERS

COQUET WATER BOARD

CHLORINATION EQUIPMENT

CONTRACT NO. 18

TENDERS are invited from experienced manufacturers for the SUPPLY and INSTALLATION of CHLORINE DOSING and ANCILLARY EQUIPMENT at the Board's Filtration Works and Pumping Station, Warkworth, Northumberland.

Tender documents, including general conditions of contract, specification and drawings, can be obtained from Mr. S. G. Barrett, Engineer and Manager, The Coquet Water Board, P.O. Box No. 104, Pilgrim Street, Newcastle upon Tyne, 1.

Tenders are to be returned in the plain envelope provided to the undersigned not later than 10 a.m. on Tuesday, the 12th April, 1960.

The Board do not bind themselves to accept the lowest or any Tender and reserve the right to accept the whole or any part of any Tender received.

FRED. G. EGNER,
Clerk and Solicitor to the Board.
14, Northumberland Square,
North Shields. E9242

INDIA STORE DEPARTMENT

STEEL BARS HOT ROLLED

Director General, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3, invites TENDERS for :—

	Quantity Tons
STEEL BARS HOT ROLLED, 1¼in. diameter. The bars to be sized and rounded to a tolerance of +0·010in.–0·003in. by a drawing pass subject to a maximum reduction by drawing of 0·015in. Bars to be subsequently reeled.	150

Forms of Tender may be obtained from the above address at a fee of 10s., which is not returnable.

If payment is made by cheque, it should please be made payable to " High Commission for India."

Tenders are to be delivered by 2 p.m. on Monday, 25th April, 1960.

Please quote Reference No. 8/59/RLY.1. E9224

EDUCATIONAL

COLLEGE OF AERONAUTICS

A Course of Lectures on

PROBLEMS IN HYPERSONIC AERODYNAMICS

will be given at the College from

Monday, 2nd May, to Friday, 13th May, 1960.

The course is intended for aerodynamicists, physicists and research workers who require a working knowledge of hypersonic aerodynamics. A knowledge of subsonic and supersonic aerodynamics and of mathematics up to degree level is desirable.

FEES for the course are :
Tuition Fee, 30 guineas.
Residence Charge (including full board), 10 guineas.

Forms of enrolment and copies of the syllabus may be obtained from the Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E9244 E

QUEEN MARY COLLEGE
(UNIVERSITY OF LONDON)

POSTGRADUATE DIPLOMA IN NUCLEAR ENGINEERING

A ONE-YEAR COURSE OF STUDY IN APPLIED NUCLEONICS AND REACTOR THEORY will be given during the Academic Year 1960–1, and will prepare students for the above diploma. A good Honours Degree in Engineering, Science or Mathematics is a necessary entry requirement. Studentships will be available to suitably qualified applicants but immediate application is necessary.

A brochure describing the Course can be obtained from the Secretary, Nuclear Engineering Laboratory, Queen Mary College, Mile End Road, London, E.1. E9232 E

A.M.I.MECH.E., B.Sc., City and Guilds, etc. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

ASSISTANT to Managing Director. A young and expanding firm in S.E. Kent producing diesel electric sets for world-wide markets requires man with similar practical and technical experience to organise Sales and Service. Personality, initiative and similar background are essential. The post will involve world travel at intervals.—Detailed history and salary required to BOX No. E2766, " The Engineer." A

SITUATIONS VACANT

APPLICATIONS ARE INVITED FROM

DESIGN AND DETAIL DRAUGHTSMEN

for general mechanical engineering work in connection with the design and manufacture of chemical works plant. Knowledge of general fabrication, pressure vessels, pipe work and general layout of chemical plant would be advantageous. Permanent positions at good salaries. Staff hostel. Assistance in obtaining houses. Allowance until removal effected. Grant towards removal expenses. Life assurance and Pension Scheme.

Apply in writing to

THE PERSONNEL AND TRAINING MANAGER,
THE POWER GAS CORPORATION LTD.,
STOCKTON-ON-TEES.

E9175 A

ASSISTANT ENGINEER for Chemical and Metallurgical Plant Maintenance. Age 25 to 30. Engineering Degree or A.M.I.M.E. desirable and at least five years' practical experience in heavy industry required. Staff pension scheme. Five-day week.—Written applications to Personnel Officer (Staff), Magnesium Elektron Limited, P.O. Box 6, Lumm's Lane, Clifton Junction, Swinton, near Manchester. E9227 A

BRIAN COLQUHOUN AND PARTNERS require immediately in their London and Manchester offices, SENIOR DESIGNERS and DETAILERS of Reinforced and Pre-stressed Concrete Structures. Three years' minimum experience in this type of work essential. Salary : £900–£1200 per annum. Holidays and usual benefits.—Apply, Brian Colquhoun and Partners, 18, Upper Grosvenor Street, London, W.1, or telephone Mr. Lance, Mayfair 9636. E2762 A

BRITISH CONCERN having extensive interests in Commonwealth West Africa require an ENGINEER to handle refrigeration and air conditioning. Wide experience of the practical side of this work essential, with the ability to supervise site installations and plant erection, using semi- and unskilled local labour. Design experience would be useful. A good starting salary is offered, coupled with generous allowances and conditions of service. This position is initially for a contract of about 12/18 months but may become permanent. Details of age, qualifications and experience.—BOX No. E9172, " The Engineer." A

BURROUGHS WELLCOME & CO. require an ENGINEER with experience of Chemical Plant who would be responsible to the Works Engineer for plant installation and maintenance in the Chemical Division of The Wellcome Chemicals Works, Dartford. Candidates should be corporate members of the Institution of Mechanical Engineers or possess a University Degree in Mechanical or Chemical Engineering. Salary will be in accordance with qualifications and experience. Excellent staff conditions including contributory Pension Scheme. —Applications should be sent to the Personnel Manager, Wellcome Chemical Works, Dartford, Kent. E9238 A

CHIEF INSPECTOR required by large excavator manufacturing firm of some 3000 employees. Applicants must have served an engineering apprenticeship and have an " inspection " experience, dealing with machine shops, fitting and erecting, fabricating and finishing departments. Successful candidate will be required to take eventual charge of an Inspection Department consisting of 42 inspectors.—Applications in writing, giving all relevant particulars, e.g. experience, education and approximate salary, to Industrial Relations Department, Ruston-Bucyrus, Ltd., Excavator Works, Lincoln. E9243 A

COLDAIR LIMITED

East Lane, North Wembley, Middx.,

require

MAINTENANCE FOREMAN

to take control of Maintenance Department in a medium sized factory engaged in production of domestic refrigerators. Applicants should have experience of machine tools, welding equipment, factory services, &c., and be able to control millwrights, electricians, sheet metal workers, carpenters, &c.

Write in first instance, stating previous experience and qualifications, to

PERSONNEL MANAGER

E9205 A

DESIGN ENGINEERS AND DESIGNER DRAUGHTSMEN with up to seven years' experience in design of Reinforced Concrete and steel structures in connection with power stations, tunnels and railway works.—Apply, with details of experience to Sir William Halcrow & Partners, Alliance House, Caxton Street, London, S.W.1.

E9213 A

DRAUGHTSMAN ESTIMATOR required by Company in East Anglia manufacturing wide range of ferrous and non-ferrous products in mechanised foundries ; to work under Foundry Development Engineer. Young man, 21–25 years of age, with O.N.C. (at least) coupled with experience and/or knowledge of metal and wood pattern-making. Experience of foundry methods and mechanised equipment an advantage.—Write, with full particulars (in confidence) to BOX No. E9215, " The Engineer." A

SITUATIONS VACANT

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of refractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733–£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15. E180 A

DRAUGHTSMAN required for Civil Engineering Works ; experience in mechanical and marine drawing would be advantageous. Salary range : £798 to £876 per annum. Contributory superannuation scheme ; certain railway privilege travel facilities ; luncheon club.—Apply in writing, giving full particulars as to age and experience, to Divisional Staff Assistant, British Waterways, " Willow Grange," Church Road, Watford, Herts. E9228 A

DRAUGHTSMAN (age 25/30) required for varied Chemical Plant Development work. H.N.C. (Mechanical) and knowledge of plant layout and pipe work essential. Permanent and progressive post. Superannuation and profit sharing schemes. —Applications to : Personnel Manager, F. W. Berk and Co., Ltd., Canning Road, Stratford, E.15. E9218 A

DRAUGHTSMAN, Senior, for progressive firm producing Pressure Vessels and similar equipment for Chemical and Petroleum Industries. 5-day week. Canteen and Recreational facilities. Excellent conditions. Staff Superannuation Scheme. Good salary to a fully experienced candidate.—Towler & Son, Riverbank Works, Sugar House Lane, Stratford, E.15. Telephone : MARyland 3214. E9246 A

ENGINEER, with H.N.C. or equivalent, and preferably with basic electrical knowledge, to undertake interesting experimental work on Mechanical and Heat Transfer Tests in Research and Development Department.—Reply, stating age, qualifications and salary required to Personnel Manager, The Superheater Co., Ltd., Ashburton Road, Trafford Park, Manchester, 17. E9216 A

ENGINEERS, Civil and Mechanical—temporary—required by Iron Ore Mining Company for one tour of approximately 18 months duty in BRITISH WEST AFRICA. Civil Engineer to supervise foundation and steelwork contracts, and Mechanical Engineer to supervise installation of plant and machinery including electrics in an ore concentrating plant. Engineers with previous experience contract supervision essential. Salary £1900 per annum, plus bonus, plus for married man marriage allowance at the rate of £10 per month and children's allowance at the rate of £5 per month for each child under 18, but bachelor accommodation only available. Dependants Income Scheme and free Life Assurance. Return passage paid. Initial kit allowance. Free furnished single accommodation and medical attention.—Write, giving full details of experience, stating age, married or single, to SIERRA LEONE DEVELOPMENT CO., LTD., Dept. M.P.4, City Gate House, Finsbury Square, London, E.C.2. E9212 A

ENGINEER-DRAUGHTSMAN required to take charge of maintenance department and assist with new developments for Chemical Fertiliser Works near Chester. Modern detached house available and superannuation scheme in operation.—Apply, Secretary, Edward Webb & Sons (Stourbridge), Limited, Wordsley, Stourbridge, Worcs. E2765 A

FIBREGLASS LIMITED require a qualified ELECTRICAL ENGINEER between 25 and 35 years of age for interesting market development work in the use of Fibreglass for electrical insulation and as a textile fibre. The post offers wide scope for initiative and requires the application of a lively mind to problems of rapidly expanding fields of use. —Applications, with full details of career and salary required to Sales Director, Fibreglass Ltd., Ravenhead, St. Helens, Lancs. E2764 A

FULLY QUALIFIED ENGINEER to be directly responsible to the Partners, required by medium-sized firm of Consulting Engineers in Westminster. Should have had varied civil and structural engineering experience, including road, bridge and railway works. Age 35-45.—BOX No. E9199, " The Engineer." A

HEATING AND VENTILATING ENGINEER required in Westminster office, to deal with site measuring, costs and final accounts. Write, giving full details, including practical experience.—BOX No. E2758, " The Engineer." A

JUNIOR MECHANICAL DRAUGHTSMEN, having completed National Service, required for work on large chemical plant installations. A.E.S.D. minimum rates or above. Five-day week and superannuation scheme.—Replies, giving details of age, qualifications and experience and quoting Ref. LCL/TE1/19, should be addressed to Drawing Office Superintendent, LAPORTE CHEMICALS LIMITED, Oyez House, Fetter Lane, London, E.C.4. E9195 A

REQUIRED TO TRAIN AS TECHNICAL REPRESENTATIVE, young man 20-21 years of age, sound education, preferably board school. Previous experience not essential, but engineering background an advantage. Successful applicant would first undergo training at our Head Office, Stafford, for a period of six months and later be located as a junior Technical Representative. The position carries salary, commission, car and out-of-pocket expenses and the Company operate a contributory superannuation scheme.—Apply in writing to the Weldmesh Sales Director, The B.R.C. Engineering Company, Stafford ; giving details of age, education, experience, including information as to whether eligible for National Service. E9196 A

MECHANICAL AND CIVIL ENGINEERING DRAUGHTSMAN required for a Drawing Office engaged on all types of work connected with Mining, Quarrying, Hydraulics and Industrial Building Construction. A superannuation scheme is in operation.—Applications, stating qualifications, experience and salary required, should be made to the Chief Engineer, English Clays Lovering Pochin and Co., Ltd., 14, High Cross Street, St. Austell, Cornwall. E9193 A

NUCLEAR ENGINEERING

ENGINEERS required for design and development work on heat exchangers, steam generators, pressure vessels and other components associated with advanced types of nuclear reactors and with other advanced systems in the power and propulsion field. Applicants should hold a Mechanical or Chemical Engineering Degree and should preferably have some previous experience in design or development of heat exchangers and high pressure steam plant. Commencing salary in range £900–£1450 per annum, according to experience. Contributory Pension Scheme.—Application should be made in writing, giving details of age, qualifications and experience, to :

Staff Manager,
FOSTER WHEELER LIMITED,
3, IXWORTH PLACE,
LONDON, S.W.3.

E9234 A

PLANNERS/RATEFIXERS AND ESTIMATORS FOR SOUTH AFRICA

Leading Heavy Engineering Works in South Africa requires Planners/Ratefixers and Estimators. Applicants must have served a fully recognised apprenticeship as Fitters and Turners, and must have thorough experience of this type of work.

Minimum inclusive salary £1150 per annum, but salary will be paid according to qualifications and experience. Good prospects for the right persons.

Housing available. Pension and Medical Benefit Funds. Facilities exist for advancing travelling expenses to South Africa on contract basis.

Write, stating age, qualifications, present salary, previous experience and marital status, to BOX 101, c/o Walter Skinner, Ltd., 20, Copthall Avenue, London, E.C.2. E9136 A

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential and applicants with general mechanical engineering experience will be favourably considered. The posts offer opportunities and salaries consistent with experience and ability. Modern offices situated in the London, E.C.4, area. Five-day week and superannuation scheme.—Applications, which will be treated in the strictest confidence, giving details of age, qualifications and experience and quoting Ref. LCL/TE1/20, should be addressed to the Group Personnel Manager, LAPORTE INDUSTRIES LIMITED, Hanover House, 14, Hanover Square, London, W.1. E9194 A

TECALEMIT LIMITED, PLYMOUTH, DEVON

have a vacancy for a SENIOR ASSISTANT in the Physical Laboratory of the Research Department.

The work involves research and control on non-metallic materials such as filter media, plastics, rubber and adhesives.

Applicants should have a University Degree in Mechanical Engineering or equivalent qualification, with an interest in physics or technology ; research experience with one of the materials mentioned and some experience in statistics as applied to planning and evaluating experimental work will be an advantage.

The finally selected candidate will find interesting and varied work as the leader of a team in a progressive and active modern factory. His salary will be commensurate with his qualifications and experience.

The Company operates a contributory superannuation and life insurance scheme.

Applications should include details of age, education and experience, and be addressed to the Employment Officer. E2750 A

THE BOWATER PAPER CORPORATION LIMITED HAVE A VACANCY FOR A REINFORCED CONCRETE DESIGN DRAUGHTSMAN. Applicants should have had experience in the design of reinforced concrete structures, roads, tanks, foundations, &c. Applications will be treated confidentially. They should state details of age, education, training and experience and salary required and should be sent to the Chief Engineer, the Bowater Paper Corporation Limited, Engineering Division, Northfleet, Kent. E9219 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, " The Engineer." A

WELDING TECHNICIAN required at the Tube Investments Technological Centre for interesting development work which initially will involve the inert gas and metal arc welding processes, both manual and automatic. An H.N.C. or equivalent, with some experience of the above techniques, are desirable.—Apply, giving full details of experience, &c., to the Secretary at the Airport, Walsall, Staffs. E9220 A

SITUATIONS VACANT

ASSISTANT ELECTRICAL AND INSTRUMENT ENGINEERS

are required by the

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

(PRODUCTION GROUP)

WINDSCALE AND CALDER WORKS, CUMBERLAND

to assist in a section providing an engineering service for the Advanced Gas Cooled Reactor, its associated auxiliaries and generating plant. This Reactor, now under construction, is an experimental prototype operating at high temperatures and ratings, for developing and proving this system for use in the civil power programme. A desire to work on the problems associated with a prototype reactor is an essential requirement.

Applicants must have served a recognised engineering apprenticeship or have had comparable training, and be Corporate Members of a recognised Senior Engineering Institution. At least three years' relevant engineering experience is essential.

Salary within the scale £860 (at age 25)–£1340 per annum.

Contributory Superannuation. Staff Housing Scheme.

Send postcard for application form, quoting reference number P/W.18/J1 to Recruitment Officer, Windscale Works, Sellafield, Seascale, Cumberland.

CLOSING DATE: 8th APRIL, 1960

E9200 A

SITUATIONS VACANT

CANADA

ELECTRONIC PROJECT ENGINEERS

Opportunity with an expanding Ontario Company.

Projects include design and development of Sonar and Marine electronic equipment.

Approximately five years' experience. Background in Sonar, Pulse, and Audio fields preferable, but not mandatory.

Very liberal health insurance, group insurance, and pension plans.

For applications form write to :

Dept. E.C.L.,
National Employment Service of Canada,
61, Green Street, London, W.1

E9214 A

BABCOCK & WILCOX LIMITED

PROJECT DESIGN ENGINEER

A vacancy for a PROJECT DESIGN ENGINEER exists in the Atomic Energy Department situated at the Company's Head Office in London.

Applicants should be capable of original design in the fields of mechanical and thermal engineering, and should be able to take charge of design work in the first place of components, and later the whole, of a nuclear steam generating plant.

The duties include analysis of clients' requirements, adaptation of existing knowledge, invention of new solutions, and co-ordination against a limited time schedule of work inside and outside the Company up to the tendering stage.

Experience in the atomic energy industry would be an advantage, but not so essential as competence in project engineering as defined above.

Write, stating age and qualifications to :

The Assistant Secretary,
(Ref. E),
209, Euston Road, London, N.W.1.

E9208 A

SITUATIONS VACANT

CHIEF INSPECTOR

required by a Company specialising in the grinding and manufacture of the highest quality Gearing and Production of Machine Tools and Measuring Instruments. Qualifications required include full experience of the latest gear measuring and inspection techniques together with knowledge of A.I.D. procedure. This position, which includes responsibility for an up-to-date Gearing Standards Room is a permanent one, offering much interest to the successful applicant and comes within the scope of the Company's Superannuation Scheme.—Applications should be made, giving full particulars of experience, &c., to Company Secretary, The Gear Grinding Co., Ltd., Cranmore Boulevard, Shirley, Solihull, Warwickshire.

E9202 A

ALFA-LAVAL COMPANY LIMITED

require a

MECHANICAL ENGINEER

for special service, inspection, field testing and development in connection with their high speed centrifuges.

Excellent progressive opportunity for young engineer of suitable technical qualifications and with knowledge of materials, machining and design.

Apply by letter, stating age, training, qualifications and experience, to :

Ref.: DGG,
ALFA-LAVAL COMPANY, LTD.,
GREAT WEST ROAD,
BRENTFORD,
MIDDLESEX.

E9217 A

SITUATIONS VACANT

ELECTRICAL DESIGN ENGINEER

A Graduate is required for the position of Electrical Design Engineer at this fully integrated Iron and Steel Works situated on the West Coast of Cumberland.

The work is extremely varied ranging from High Voltage Power to Control Engineering.

Good Life Assurance and Contributory Pension Scheme.

Applicants, who should have had practical experience subsequent to a recognised training scheme, should write to The Secretary, Workington Iron & Steel Company (a Branch of the United Steel Companies Limited), Moss Bay, Workington, Cumberland.

E9222 A

AEI

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

INSTRUMENTATION DIVISION, HARLOW, ESSEX

A SENIOR ESTIMATING ENGINEER

is required for the Process Control Contracts Department in the Instrumentation Division. He will be responsible for preparing estimates for a wide variety of panel schemes involving electro-mechanical equipment and covering all fields of the process industries.

The successful applicant must be a fully experienced Estimator with considerable experience of this class of work. He will be based at HARLOW, ESSEX, and housing for rental may be made available if required. Written applications, which will be treated in strictest confidence, must include full details of age, qualifications, experience and present salary, and should be addressed to the Personnel Officer, A.E.I. Instrumentation Division, P.O. Box No. 1, HARLOW, Essex. E9207 A

SENIOR ENGINEER

is required at the London Head Office of a large Industrial Company.

The appointment, which arises owing to the continued expansion of the Company's activities, provides an outstanding opportunity for a first class Engineer who wishes to obtain a Senior appointment which includes both Engineering and Administrative responsibilities. The salary will be fully commensurate with the duties involved.

Applicants, who should be aged 30–35, must be University Graduates in Chemical or Mechanical Engineering. Industrial and Administrative experience are essential qualifications.

Please write giving full details of career to :

PERSONNEL MANAGER,
BOX No. E2763, "The Engineer."

A

SHELL-MEX AND B.P. LTD.

have vacancies in the U.K. for

QUALIFIED ENGINEERS

Candidates should have had thorough training in workshops and possess either Corporate Membership of the Institutions of Civil or Mechanical Engineers or have passed parts A and B of one of these Institutions' examinations or have qualifications entitling them to exemption from such examinations. Experience on pumps and pipelines or building construction would be advantageous.

Conditions of employment are excellent and there is a good Pension Scheme. Starting salary will depend entirely on qualifications and experience. Replies, marked Ref. CA/85, should be sent to :—

The Staff Manager, Shell-Mex and B.P. Ltd.
Staff Dept., Shell-Mex House, Strand, W.C.2.

E9130 A

British Titan Products Co Ltd

invites applications for the vacancy of

PLANNING ENGINEER

in the Chief Engineer's Department at
BILLINGHAM, CO. DURHAM

The Company is a rapidly expanding chemical concern manufacturing Titanium Oxide.

Minimum qualifications are H.N.C. in Mechanical or Electrical Engineering with experience in programming and job planning of large engineering contracts. In addition, since the successful applicant will also be Personal Assistant to the Chief Engineer, he should have substantial experience in administrative work. The age range envisaged is 28–40.

Conditions of service are considered well above average and include such benefits as Annual Bonus Scheme and Non-contributory Pension and Life Assurance Scheme ; housing assistance, &c.

Applications, which will be treated in confidence, should be addressed to The Personnel Manager
BRITISH TITAN PRODUCTS CO., LTD.,
Billingham, Co. Durham, *quoting reference S.3.*

E181 A

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Interviews can be arranged to suit applicants' convenience.

Write particulars age, previous experience, and any qualifications, such as O.N.C., to the Personnel Manager.

E9068 A

Classified Advts. continued on page 120

SITUATIONS VACANT

LOEWY

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EXPERIENCED DRAUGHTSMEN for the rolling mill and hydraulic divisions.

DESIGNERS AND DRAUGHTSMEN for special purpose machines.

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E9221 A

SITUATIONS WANTED

ENGINEER, A.M.I.Mar.E., M.O.T. 1st Class Combined experience. High-rated steam and diesel power plants, all types, plant installation, steel erection, heavy foundation work, workshops. Willing to travel anywhere. Good personality. Hard worker. Age 34. Any progressive concern.—BOX No. E2754, " The Engineer." B

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E2723 MW

PATENTS

THE PROPRIETOR of British Patent No. 685,723, entitled " SPRING FORMING MACHINE," offers same for License or otherwise, to ensure practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, 14, E. Jackson Blvd., Chicago, 4, Illinois, U.S.A. E9187 H

THE PROPRIETOR of British Patent No. 723,197, entitled " STONE-CUTTING CABLE SAW," offers same for Licence or otherwise to ensure practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, 14, E. Jackson Blvd., Chicago 4, Illinois, U.S.A. E9231 H

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E9064 O

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E200 K

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E179 G

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E207 G

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E205 G

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E R

By Order of the Secretary of State for War

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		Main Location	*Auctioneers*
March 22–24	**Machine tools, vehicles and miscellaneous stores,** including :—	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
	Approximately 60 S.S. and S.C., G.P. and centre lathes, motorised, 7in. to 20in. swing, 5in. to 48in. centres; lapping and grinding machines; surface grinders; horizontal and vertical milling machines; pillar drills; power hacksaw; circular saws and blades; trolley mounted electric welders; vehicle washing plants; Tecalemit greasing units; generators; searchlights and spares; predictor units; grinding wheels; electric cable; copper wire; loudspeaker units; vibrators 12V.; transformers; 2500 telescopes; periscopes; wrist and pocket watches; drawing instruments; tubular scaffolding; steel binning; furniture; cardboard boxes; canvas covers; a very large quantity of pull-throughs; Caterpillar engines (D.7's), starting engines, crankshafts, piston pins and injectors; M.T. spares for British and American vehicles and motor-cycle spares; approximately 750 vehicles, trailers and motor-cycles, including saloons by Austin, Humber and Vauxhall, light utilities and Land Rovers; load carriers by A.E.C., Austin, Bedford, Morris and Thornycroft 1–10 tons; tractors; mobile water tankers 100 and 500 galls.; ambulances; trailers 10 cwt. and 1 ton; 350 solo motor-cycles by B.S.A. and Matchless, including many with telescopic forks.		
March 30	**Machine tools and miscellaneous stores.**	Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorks.	**BARTLE & SON** (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)
April 8	**Miscellaneous stores.**	Returned Stores Group, Reed Hall, Colchester, Essex.	**FENN, WRIGHT & CO.** (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
April 21	**Machine tools and miscellaneous stores.**	M.O.A. Storage Depot, Rotherwas, Hereford.	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)

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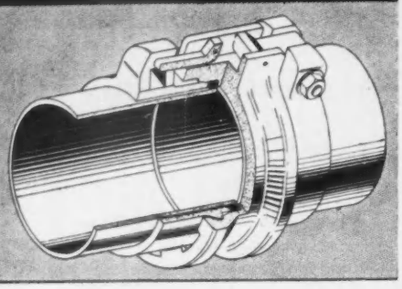

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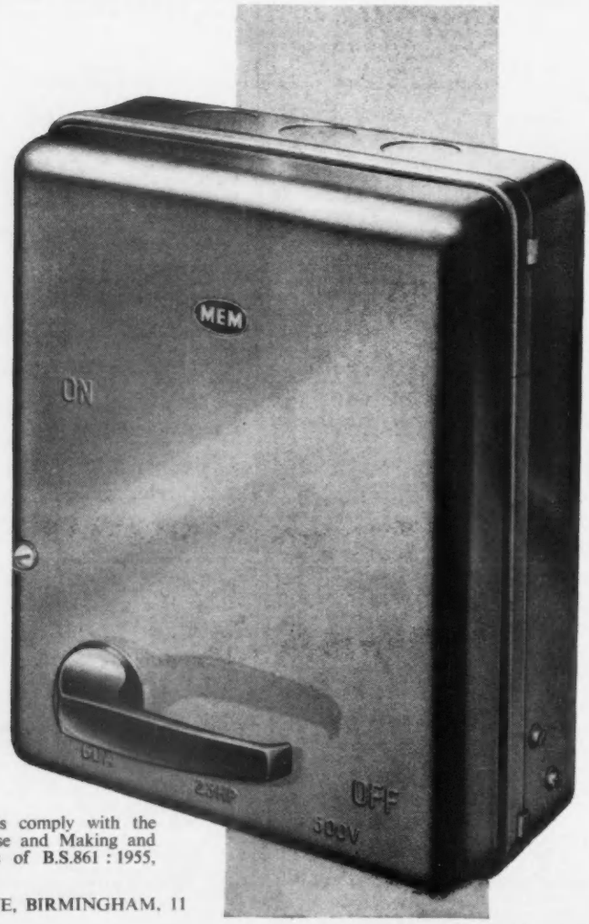

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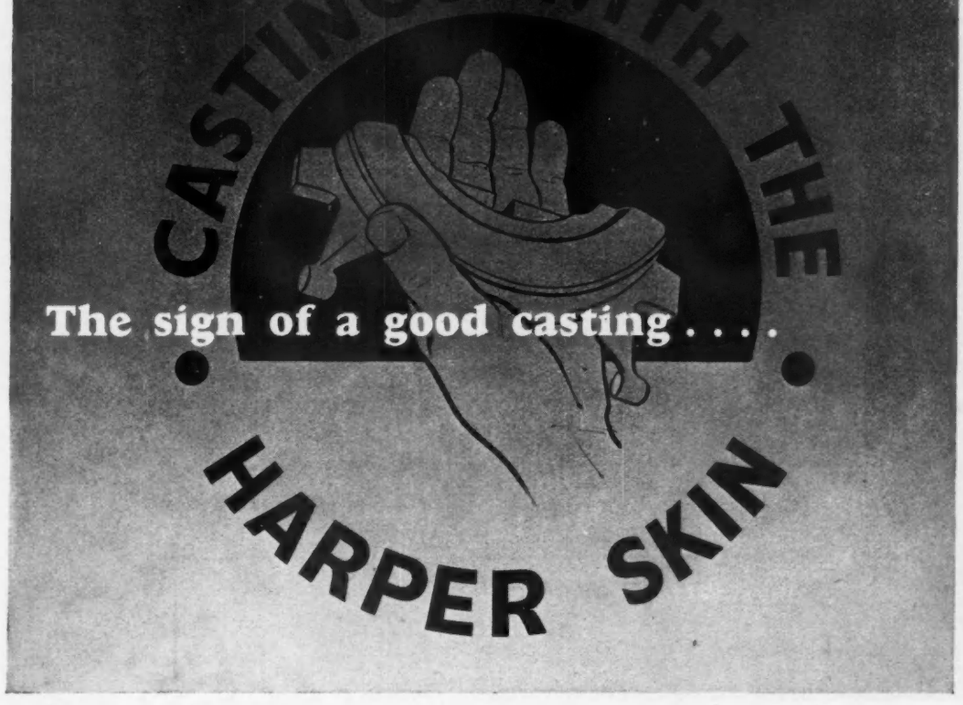

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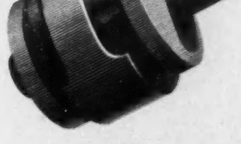

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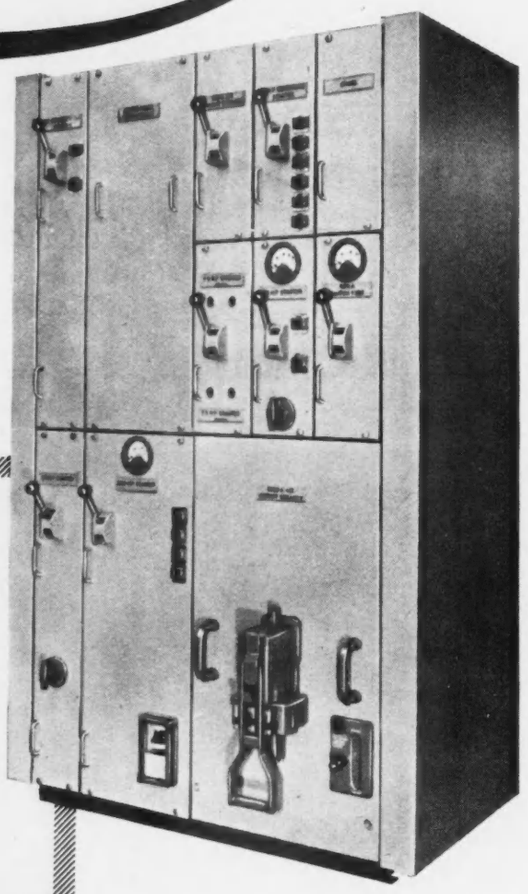

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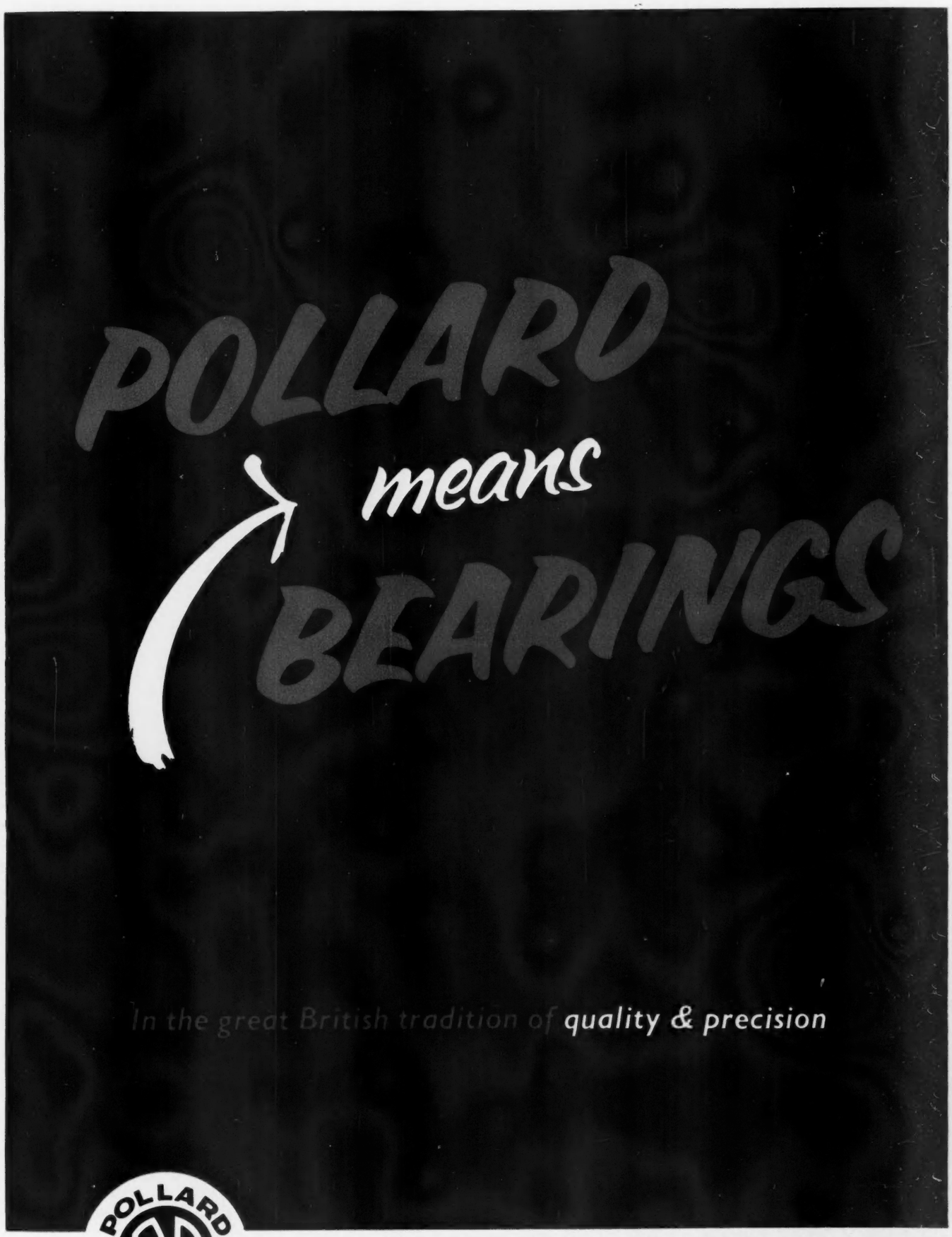

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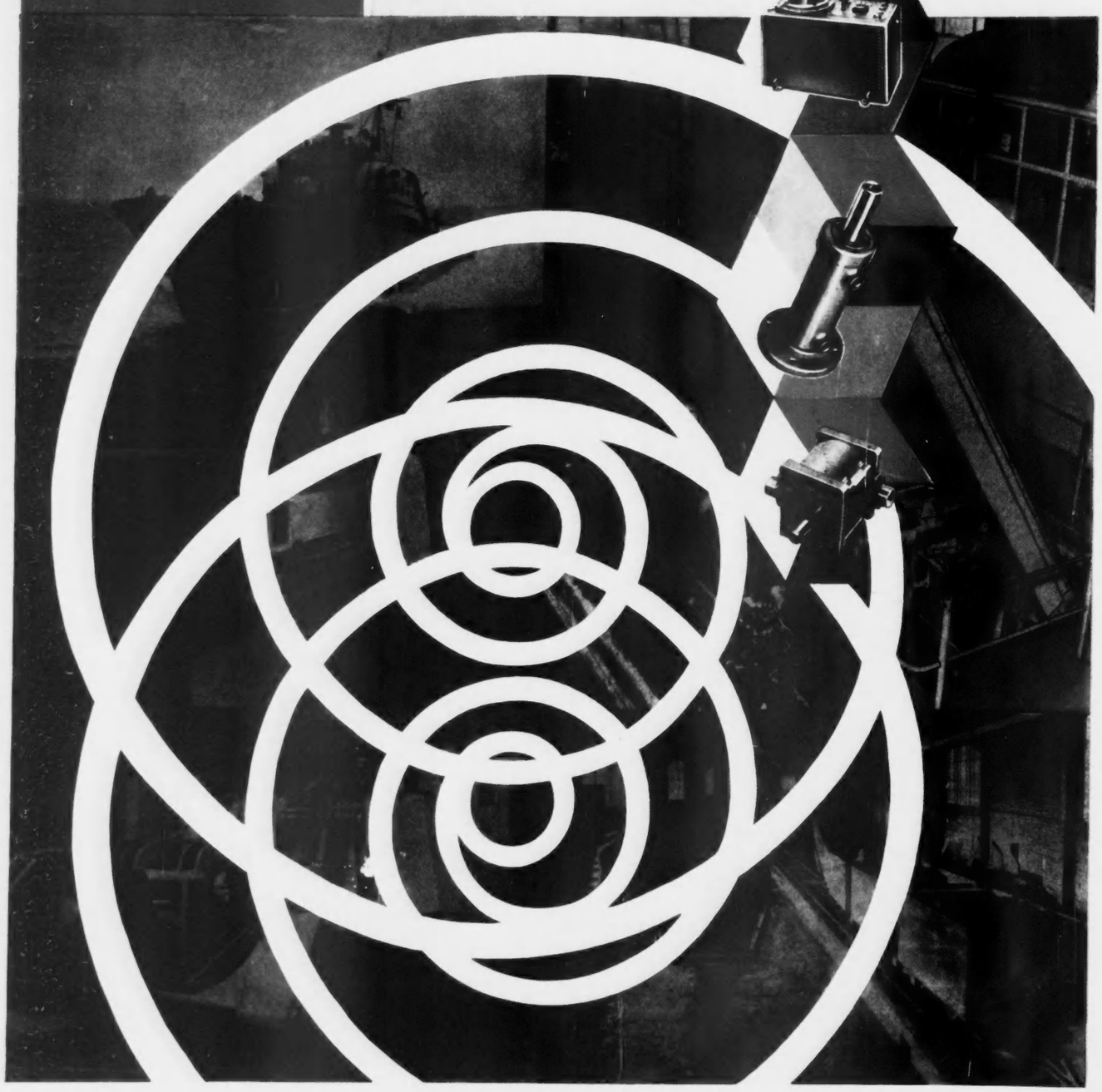

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